Division of Aquatic and Wildlife Resources

Guam Department of Agriculture

Annual Report Fiscal Year 1990

Guam.
Aquatic
and
Wildlife
Resources
Annual
Report
FY'90

ANNUAL REPORT
FISCAL YEAR 1990

GUAM
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PERIOD COVERED:
October 1, 1989 to September 30, 1990

Guam. Aquatic and Wildlife Resources Annual Report

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Wildlife Inspector George Phocas, Division of Law Enforcement, U.S. Fish and Wildlife Service, U.S. Department of the Interior.

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JOB PROGRESS REPORT
COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: C-1
JOB NO.: 1

JOB TITLE: Coordination of Guam's Fish and Wildlife Programs

PERIOD COVERED: October 1, 1989 to September 30, 1990

OBJECTIVES

To plan, coordinate, supervise, and administer all fish and wildlife restoration programs.

PROCEDURES

1. Supervise the planning and documentation of the Fish and Wildlife programs.

2. Administer all fiscal and budgetary matters and coordinate with the Central Accounting and Budget Office.

3. Administer all personnel matters including recruitment of off-island staff.

4. Represent the Division and Department of Agriculture in all matters pertaining to Fish and Wildlife Resources.

RESULTS

The Division experienced several staff changes during the year. Paul Conry resigned in December, 1989 to take a position with the Hawaii Division of Forestry and Wildlife. Robert Beck was promoted to Wildlife Biologist IV. Celestino Aguon was hired as the new Game Management Biologist. Oscar Mata resigned as Fisheries Technician. Herman Muna and Jesse Guerrero were reclassified as Technician II, while Ester Arca, Robert Cruz, and Glenn San Nicolas were reclassified as Technicians I. Derrick Kowalski was also hired as a Wildlife Biological Aide.

Division staff spent the first quarter preparing the annual Job Progress Reports on the research and other activities conducted during FY89 under its various federal programs and submitted them to the U.S. Fish and Wildlife Service Regional Office.

Staff also devoted considerable effort to preparing the Federal Aid project documentation necessary to obligate funds for the Division's various programs during FY90. This documentation included a new Application for Federal Assistance for the Guam Fisheries Development and Endangered Species Investigations projects for the next five year period, as well as annual Project Agreements for the various Fish and Wildlife Investigations that the Division conducts. These project documents received federal approval during the reporting period.

In addition to Federal Aid Program documentation, staff devoted considerable effort to preparing various project proposals and budget requests for Brown Tree Snake research funds through a $1 million appropriation to the Office of Territorial and International Affairs for this purpose.

Fiscal and budgetary activities included monthly preparation and submission of reimbursement vouchers for our various Federal Aid programs and coordination with the Government Accounting and Budget Offices to ensure fiscal integrity.

The Division Chief and his staff represented the Division and the Department of Agriculture in all matters relating to fish and wildlife resources. This frequently entailed meetings with other agencies of the Government of Guam, various Federal agencies, and the military.

Considerable effort was also invested into preparing submittals for the Department's oversight hearings before the Committee on Economic Development at the 21st Guam Legislature, and for the Department's FY90 budget hearing before the Committee on Ways and Means. A budget plan that proposes a significant increase in the level of local funding for the Division's programs was also prepared and submitted to the Bureau of Budget and Management Research.

The Chief served on the Department's Land Lease Approving Committee, which must review and approve all proposed leases of government land for agricultural purposes. The Chief also served as the Government of Guam's representative to the Western Pacific Regional Fisheries Management Council.

Division staff made a number of off-island trips related to Federal Aid programs.

Fisheries Biologist Gerry Davis and Rob Myers attended the Western Pacific Region Fisheries Management Plan Monitoring meetings in Hawaii held in October, May, and August. Mr. Myers was unable to attend the May meeting.

Wildlife Biologist Robert Beck visited Hawaii Forestry and Wildlife's crow captive breeding facility on Maui in late October. He then traveled to the Smithsonian Institute's Conservation and Research Center in Virginia for an American Association of Zoological Parks and Aquarium Species Survival Program Masterplanning Workshop for the Micronesian Kingfisher and Guam Rail in early November

Division Chief Rufo J. Lujan represented the Government of Guam at the Western Pacific Regional Fisheries Management Council, which met in Hawaii in December, June and September in Honolulu. An April Council meeting was also hosted on Guam, which Mr. Lujan also attended.

Fisheries Biologist Gretchen Grimm traveled to Hawaii in December and spent a week being trained by National Marine Fisheries Service Staff in the extraction, preparation and reading of fish otoliths.

Wildlife Technician, Herman Muna accompanied the shipment of 20 rails to Rota in December and to also assist in the preparation for the release of the birds into the wild.

Assistant Chief Robert D. Anderson, PIO Lillian Mariano, Staff Wildlife Biologist Robert Beck and Technician II Herman Muna traveled to Rota for a four-day stay to release 20 captive breed rails into the wild in January.

Division Chief Rufo Lujan attended the critical habitat meetings in Hawaii during February.

Fisheries Biologist Rebecca Hensley attended a five day educational workshop held in March on Creel and Angler Surveys in Fisheries Management and was sponsored by the U.S. Fish and Wildlife Service in Houston, Texas.

Fisheries Biologist, Tim Sherwood, attended a one-week Coastal Zone Management conference hosted in Washington D.C. in March.

Robert D. Anderson traveled to Denver Colorado to attend the one-week meetings of the 55th North American Wildlife Resources Conference held in March. While there, he also attended portions of the military Fish and Wildlife Association meetings, which were held in conjunction with the North American.

Members of the staff presented papers and participated in the conference hosted by the Guam National Parks Service in April, which focused on "Interpreting Critical Issues in Resource Management". Celestino Aguon, Michael McCoid, Rob Myers and Gerry Davis all made presentations.

Mr. Rufo Lujan attended a five-day Congress of Marine Tourism Conference held in Honolulu, Hawaii in May.

The Public Information Officer traveled to Vermont in June to attend the six day Third Annual Wild Branch Workshop In Outdoor, Natural History and Environmental Writing at Sterling College.

Officers, Mike Reyes and Jimmy Camacho attended a two-week training "Wildlife Covert Investigations" hosted by the U.S. Fish and Wildlife Service at the federal Law Enforcement Training Center in Glynco, Georgia in July.

Robert Anderson attended the Hunter Education Conference held in Hawaii in August, which was sponsored by the U.S. Fish and Wildlife Service.

Fisheries Biologist Gretchen Grimm was locally funded to attend the Micronesian Games held in Saipan in July to represent Guam as an official in the spearfishing competition.

Assistant Chief Robert Anderson was locally funded to attend a one-week meeting of the North American Wildlife Law Enforcement Officers Association held during July in Jackson Wyoming.

Rufo Lujan accompanied by: Assistant Chief Robert Anderson; Wildlife Biologists Gary Wiles and Mike McCoid; and PIO, Lillian Mariano; attended the technical workshop on the Brown Tree Snake held in Honolulu Hawaii in August.

Fisheries Biologist Gerry Davis spent five days in Noumea for the South Pacific Commission's (SPC) 22nd Regional Technical Meeting on Fisheries in Noumea. Mr. Davis represented the Government of Guam and presented information concerning FADs to other SPC members, which was funded by the SPC.

Fisheries Biologist Gerry Davis spent two weeks in August assisting the Palau Marine Resources Division in the preparation, training and deployment of fish aggregating devices. This project was funded by the SPC.

Wildlife Biologist Mike McCoid presented a paper at the Annual Conference on the Study of Reptiles and Amphibians held in Louisiana in August. After the meeting, he proceeded to Washington D.C. to examine preserved specimens.

In September, Rufo Lujan traveled to Saipan, Commonwealth of the Norther Mariana Islands to represent the Government of Guam in discussions on the Exclusive Economic Zone on fisheries matters.

The Division hosted a number of off-island visitors during the year. Robert Smith, Al Marmelstein, Ernie Kosaka, Andy Yuen, Tom Fritts, Steve Gotte, John Engbring, Gordon Rodda, Fred Caslick , Herb Roche and Bill Dusel all of the U.S. Fish and Wildlife Service; Dave Hamm and Joe Koczur of the National Marine Fisheries Service; members of the Western Pacific Regional Fisheries Management Council, Merlin Tuttle of Bat Conservation International; Carolyn Imamura of the Pacific Basin Development Council; William Paty of Hawaii's of Department of Natural Resources; Carroll Cox of U.S. Fish and Wildlife Enforcement; Derek Scott of Oceanic Wetland Inventory; Chuck Stone of the National Park Service; Dr. Stuart Pimm,Professor of Zoology at University and his graduate student, Gregory Witteman; Leli Sheeline of Yale University; S. Dillon Ripley of the Smithsonian Institute; David Stedman of the New York State Museum of Natural History, Scott Derrickson of the Smithsonian Institute; Deiter and Mary Plaga of Survival Anglia Films; Manuel Santana, graduate student at the University of Arizona; David Itano of the South Pacific Commission; Andrew Wright of Forum Fisheries Survivor and John Groves, Curator of Birds at the Philadelphia Zoo all visited the division at various times and for various lengths of stay.

Numerous representatives of the CNMI Department of Natural Resources, including Biologists, Clifford Rice, Jim Reichel, and David Aldan, visited during the year to discuss subjects of mutual interest.

Report prepared by: Gerald W. Davis

JOB PROGRESS REPORT
COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: C-2
JOB NO.: 1

JOB TITLE: Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources.

PERIOD COVERED: October 1, 1989 to September 30, 1990

BACKGROUND

The Division's professional staff devoted a significant percentage of their time and effort to technical assistance. The rapid pace of development on the island is requiring increasing amounts of time from the Division's staff to fulfill its statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications. Because of the size and complexity of some of these developments the Division's review responsibility will require a continuing commitment that could extend even beyond project completion.

OBJECTIVES

1. To minimize adverse environmental impact resulting from the construction of recreational, commercial, residential, industrial or public utility facilities.

2. Provide technical assistance to military and civil agencies relative to the management and protection of fish and wildlife resources.

FINDINGS

The staff of the Division has been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the Division for review. Field investigations and meetings with responsible agencies have been conducted in many cases as part of the review process.

Various Division staff members actively serve as members of the following groups:

1. Ad Hoc Fisheries Council

2. Region IX Regional Response Team-Oceania

3. Brown Tree Snake Task Force

4. Subdivision and Development Review Committee

5. Agricultural Lease Approving Committee

6. Fish and Wildlife Conservation Committee- Andersen Air Force Base

7. Water Use Master Plan Task Force

8. Western Pacific Regional Fisheries Management Council

9. Western Pacific Regional Pelagic Plan Monitoring Team

10. Western Pacific Regional Bottomfish Plan Monitoring Team

11. Exotic Species Importation Review Panel

12. Bird Aircraft Strike Hazard Committee - Andersen Air Force Base

Members of the Division have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Division staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, U.S. Army Corps of Engineers (ACOE), the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the U.S. Navy, the U.S. Coast Guard, the U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with the numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by Division staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspaper, staff members participated in National Wildlife Week, Chamorro Week, Earth Week and Environmental Fair activities and gave talks to a number of civic groups, sportsman clubs, and school and university classes.

Some specific Technical Assistance activities by the Division included:

1. Representation on the Subdivision and Development Review Committee that met biweekly to review applications for rezoning, variances, and various types of development. The Division's input at this level is very important in ensuring that the protection of Guam's fish and wildlife resources are considered in land use planning.

2. Reviewed and commented on ACOE applications for wetland fill for the Island Equipment Company, Talofofo Golf Resort and Manengon Hills Resort. Mitigation recommendations were included in these comments.

3. Provided comments to the ACOE concerning wetlands violations at Manengon Hills Resort, Island Equipment Company, Talofofo Fish Ponds and the Taitano wetland in Yigo.

4. A member of the Division staff participated in wetlands delineation surveys of proposed developments with both federal and local agencies for the Guam First Green Golf Course, Manengon Hills Resort, Ordot Light Industrial Park, Ylig Bay Development and Talofofo Golf Resort.

5. Review and comments on numerous Environmental Impact Statements/Assessments of proposed developments. These comments included recommendations for grading and clearing, erosion control, project design and orientation. These recommendations were made to reduce and/or eliminate impacts to the immediate and adjacent environments.

6. Provided comments to the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act for the Talofofo Golf Resort, Manengon Hills Resort, Island Equipment Company and a small portion of a wetland in Mangilao.

7. Submitted information on five wetland systems on Guam to the U.S. Fish and Wildlife Service for inclusion in the U.S. Fish and Wildlife Service's Regional Wetlands Concept Plan (Plan) for the Pacific Region. All five of the wetlands systems were accepted and included in the final Plan.

8. Submitted information on 28 wetlands on Guam for inclusion in the Oceania Wetland Inventory. This inventory recognizes wetlands of international importance and offers some support for the protection of these wetlands.

9. Reviewed and commented to Public Works on the plan to widen Marine Drive near Polaris Point in Piti.

10. Provided comments to U.S. Assistant District Attorney concerning wetlands violation at the Talofofo Fish Ponds and Manengon Hills Resort.

11. Provided fisheries information to the Bureau of Planning for the development of a Recreational Water Use Management Plan for the area from E. Agana to the USO in Piti.

12. Provided comments to the ACOE concerning File No. PODCO 2105 for the placement of buoys in E. Agana Bay for jet ski operations.

13. Assisted the Criminal Investigation Division, Ministry of Justice, Bureau of Public Safety in Koror, Palau for identification of fish suspected of being illegally harvested with dynamite.

14. Provided fisheries information to the Bureau of Planning for the establishment of a Marine Conservation Area in Tumon Bay.

15. Provided comments to the Director of the U.S. Fish and Wildlife Service on the revision of the Environmental Impact Statement for the Sport Fish and Wildlife Restoration Program. The main emphasis of these comments was that island territories under U.S. jurisdiction generally have different resource structures, which do not always fit the intent of the guidelines designed to meet the needs of the states.

16. Provided comments to the Chairman of the Territorial Seashore Protection Commission for the placement of mooring buoys in Tumon Bay by Sunset Cruises.

17. Provided comments to the ACOE on File No. PODCO 2113 for the construction of an LCM ramp and maintenance dredging on Cocos Island by Cocos Lagoon Development Corporation.

18. Provided comments to the Director of Parks and Recreation on the proposal "To increase tourism through rescuing Tumon's habitat."

19. Provided comments on the Charter Boat Feasibility Study to the Director of Commerce.

20. Provided comments to the Chairpersons of the Subdivision and Development Review Committee and Territorial Seashore Protection Committee for buoy and raft placement in E. Agana Bay by Paradise Jet Ski.

21. Sought information from the Director of Land Management and the Director of Parks and Recreation for lot boundaries and possible impacts to historical sites on and adjacent to the lot proposed for construction of a replacement pier in Merizo.

22. Reviewed ACOE application No. PODCO-O 1947 for the Piti Underwater Observatory. Comments were provided to the ACOE, Subdivision and Development Review Committee and the Territorial Seashore Protection Committee.

23. Commented on ACOE application No. 2126 submitted by Guam Watersports Center, Inc. for the placement of jetski marker bouys in E. Agana Bay.

24. Provided comments to the Director of the Bureau of Planning concerning the ACOE permit application for Ocean Jet Ski Club for placement of jet ski marker buoys in E. Agana Bay.

25. Provided comments on ACOE File No. 2127 to the ACOE for a major dredging operation for the Achang Bay Marina.

26. Provided comments on the ACOE application by Polar International for the placement of a mooring buoy in Apra Harbor to the Director of the Bureau of Planning.

27. Provided comments to the Director of the Bureau of Planning and the ACOE on ACOE application File No. 2131 by GG Cruises Co., Ltd for the installation of two mooring buoys; one each in Apra Harbor and Sella Bay.

28. Provided comments to the ACOE on the application by Umidori Cruises to install three mooring buoys; one each on Western Shoals, Family Beach and Fingers Reef.

29. Issued a favorable reply to the Director of the Bureau of Planning concerning the ACOE application for the proposed construction of a dock for Jungle River Cruises on the Talofofo River.

30. Provided comments to the ACOE on ACOE File No. IL 2146 for the placement of marker buoys for a water ski slalom course in Apra Harbor.

31. Provided comments to the ACOE on ACOE File No. PODCO 2139 for dredging, replenishment of the beach and extension of the seawall at the Dai-Ichi Hotel on Tumon Bay.

32. Provided comments to the Director of the Bureau of Planning on the Federal consistency application by Windjammer Cruises for the installation of a heavy weather mooring buoy in Apra Harbor.

33. Provided information to the Bureau of Planning, Department of Land Management and the Guam Environmental Protection Agency for site locations of the proposed aquarium.

34. Reviewed and favorably commented on the ACOE application by the Marianas Yacht Club for installation of a beach platform and floating dock.

35. Reviewed and favorably commented on the ACOE application by Ocean Adventures to install four chain moorings in Cocos Lagoon.

36. Provided information to the Western Pacific Regional Fisheries Management Council on projects for bottom and pelagic fisheries. Information was provided on market sampling, biomass and stock assessment, historical and current transshipment from foreign and domestic vessels, recreational and near-water commercial vessels and public service announcements.

37. Reviewed and provided comments to the General Manager of the Port Authority of Guam on the proposed Port Master Plan. The Division's comments dealt with loss of recreational opportunities and possible environmental impacts due to expansion of the Port.

38. Reviewed and provided lengthy comments to the Director of the BOP concerning the proposed dredging of a 1000' x 150' area having a maximum depth of 3' and the construction of a 1000 feet long by 3 feet high seawall at the Fujita Hotel on Tumon Bay.

39. Reviewed and commented on several legislative bills that would affect fish and wildlife.

40. Reviewed and commented on several proposals to dispose of government land through sale, exchange or lease and made appropriate recommendations for the conservation of wildlife resources.

41. Met with government agencies and provided information on several occasions, regarding the user conflict between mechanized craft and fishermen in East Agana Bay.

42. Investigated several reports of suspected fish kills in island waters during the year.

43. Responded to many requests for information on laws and regulations pertaining to fish, wildlife, endangered species, hunting and fishing and importation of wildlife.

44. Responded to many requests for information on native wildlife, particularly endangered species.

45. Answered numerous requests for information on hunting from both on and off-island individuals. Specific requests included information on hunting areas, hunter safety classes, firearm regulations, hunting seasons and limits, and laws and regulations.

46. Staff provided technical assistance to numerous farmers and the Air Force and Navy regarding pig damage. Damage control permits were issued when warranted.

47. Several staff reviewed manuscripts for other authors and for professional journals.

48. Provided technical assistance to the Attorney General's Office in identifying illegally taken fish and wildlife and in interpreting the laws and regulations that apply to fish and wildlife resources.

49. Staff attended hunter safety briefings at Anderson Air Force Base and the Mangilao Community Center to provide pertinent information to hunters.

50. Staff made numerous presentations on fish and wildlife resources at schools and numerous other organizations during the year.

51. Staff prepared numerous press releases to keep the public informed of fish and wildlife issues including hunting and hunting seasons, brown tree snake issues, fish and wildlife laws and regulations, endangered species, fish and wildlife importation, etc.

52. Reviewed and provided comments to the U.S. Fish and Wildlife Service and the Navy on the Relocatable Over The Horizon Radar Project (ROTHR). Comments emphasized the preservation of the existing habitat and its importance for sustaining the existing endangered species that utilize this area. Additionally, alternate site possibilities were also suggested that would have much less of an impact on native forests and endangered species.

53. Technical assistance was provided to the Marianas Fishing Derby.

54. Technical assistance was provided to the Micronesia Games in Saipan for the spearfishing tournament.

55. Technical assistance and logistic support were provided to Dr.s Thomas Fritts and Gordon Rodda of the U.S. Fish and Wildlife Service, Earl Campbell of the Ohio State Cooperative Fish and Wildlife Research Unit, and Manuel Santana-Bendix of the Arizona Cooperative Fish and Wildlife Research Unit for brown tree snake research and Lili Sheeline of the Yale University School of Renewable Natural Resources for fruit bat importation and public attitudes on fruit bat surveys.

56. A member of the Division staff participated in six scheduled military customs school to address and inform new recruits of the hazards of the brown tree snake; including its biology, the inspection of cargo and the threat to other islands.

57. A member of the Division, on the request of numerous developers, met with them, their consultants and other government representatives to discuss their proposed development project and their possible impacts on endangered species, wetlands and native habitat as well as erosion, project design, etc.

58. Staff offered comments to and participated in the Western Pacific Regional Fisheries Management Council (WESPAC) Pelagic and Bottomfish Plan Monitoring Team (PMT).

59. Staff provided technical assistance to the newly assigned U.S. Fish and Wildlife Service Inspector concerning matters of recently established international restrictions on the importation of fruit bats to the Marianas.

60. Staff members provided technical assistance to personnel associated with the Guam Rail Introduction to the island of Rota.

61. Reviewed and commented on the United Light Industrial Park and Pacific Garden, Huchanao Golf Course, Lake Agat Golf Course, Marbo Cave Resort, DanDan Estates, Taotao Resort and the Faifai Resort and assessed the possible impacts these developments might have on the environment. Comments included recommendations on all phases of the development that would lessen/reduce impacts to the environment.

62. A staff member provided technical assistance to management personnel at Cocos Island to prevent the introduction of the brown tree snake to Cocos island.

63. A staff member provided technical assistance to the Guam Sweepsnakes competition. This individual provided biological, demographic, and capture information to the committee and the contestants.

64. A staff member provided technical assistance to Bat Conservation International (BCI) and the IUCN for fruit bat trade and abundance in the Marianas and Micronesia.

65. Provided comments to the Wetlands Coordination Team on the national goal of "no net loss" of wetlands.

66. A staff member provided technical assistance to the Division of Fisheries in Palau for the implementation of fish aggregating devices (FADs).

Report prepared by: Michael Ritter, Gerald Davis, and Robert Anderson

JOB PROGRESS REPORT
INFORMATION/EDUCATION PROGRAM

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: C-3
JOB NO.: 1

JOB TITLE: Public Information and Education on Guam's Fish and Wildlife Restoration and Endangered Species Programs

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

The Division of Aquatic and Wildlife Resources' (DAWR) Public Awareness and Conservation Education Program (PACE) continues to inform and educate the local community on Guam's fish and wildlife resources and the need to manage, protect and conserve these resources.

While the PACE program has targeted schools and the local population in the past, the acceleration of enforcement activities by DAWR's conservation officers has compelled the Division to include within this target group Guam's transient community, which is primarily made up of H-2 construction workers, crewmen of fishing boats, tourists and other resident aliens. During this fiscal year, nearly 30 foreign nationals were arrested and charged for coral and *Trochus* top shell harvesting violations, thus prompting the need for a broader information program to address this problem.

With the increasing concern over the island's current economic boom, the PACE Program has become in greater demand than ever. Teacher requests for class presentations have increased over the previous year. Approximately 1,900 students or 81 classes were visited this year. In comparison to last year, 75% of this year's audience comprised of students in grade levels three through seven, with the remaining 25% made up of grade levels eight through 12. In an effort to accommodate this demand, the PACE Program format has been modified to include presentations by DAWR's Conservation Officers.

In terms of information materials completed during FY90, DAWR was only able to provide funding for the printing of 5,000 pamphlets on the previously completed, Brown Tree Snake Project.

BACKGROUND

DAWR has had a Public Awareness and Conservation (PACE) Program in place since 1981. Funded originally by a grant from the Coastal Zone Management (CZM) Program under the Government of Guam's Bureau of Planning (BOP), the program became dormant in 1983 when a reduction in overall funding levels prevented the BOP from renewing the CZM grant to the Division. Funding uncertainties precluded the Division from actively continuing the program until March 1988 when it recruited a Public Information Officer.

Since then, the Division has made considerable progress in terms of rekindling public awareness, appreciation and concern for Guam's endangered species and fish and wildlife resources.

While the Division has focused on conservation ethics and the importance of conserving and preserving a vital part of Guam's natural history, it has also made considerable effort to educate the transient population many of whom run afoul of the law due to their lack of knowledge and understanding about Guam's fish and wildlife laws and regulations.

The effectiveness of these combined efforts can perhaps best be measured by the community's continuing response in reporting poaching activities to conservation officers and police, the increase in teacher requests for fish and wildlife presentations, and the willingness of the business sector to assist in the education of potential violators. As in the past, residents continue to respond to calls for snake specimens, report forest bird sightings, bring in injured birds or birds presumed to be endangered species, and generally to encourage the institution of more intensive management programs for Guam's fish and wildlife resources.

PROCEDURES AND RESULTS

To date, activities and efforts include:

1. Completion of the production of 24 (twenty-four) 30-second Public Service Announcements (PSAs) focusing on resource conservation, impacts of illegal hunting and fishing, beach safety, and Brown Tree Snake impact. The PSAs are currently being aired free of charge on KGTF (Guam's public television station), KUAM TV Channel 10, and KTGM TV 14.

2. Printing of 5,000 Brown Tree Snake information pamphlets for distribution at displays and fairs.

3. Coordination and development of cooperative poster projects with the Commonwealth of the Northern Marianas (CNMI). The posters include two sets, one on the Forest and Land Birds of the Marianas and the other on Seabirds, Shorebirds, and Waterbirds of the Marianas. While DAWR has encountered problems in securing approval for the printing of the posters by an off-island source, it appears likely that the project will overcome these problems and in fact, be completed at the beginning of the new fiscal year.

4. Continuation of a DAWR's bi-weekly column in the Guam Tribune (a thrice-weekly newspaper), entitled "Let's Talk Fish and Wildlife." Written by Division staff, the column features articles on the Division's research programs and activities, fish and wildlife laws and regulations, endangered species, habitat protection and other related topics.

5. Development of plans for DAWR's 1st Annual Kids' Fishing Derby, to be held December 1 and 2, 1990. The project constitutes a major component of DAWR's Aquatic Education plan.

6. Participation of Division staff on live radio and television talk shows. Appearances include:

(a) A return appearance on KUAM's two-hour television-radio "Programman Chamorro." Appearing on the talk show were DAWR Chief Rufo J. Lujan, Officer-

in-Charge of DAWR's Enforcement Section, Lieutenant John S. Villagomez, and the DAWR Public Information Officer, Lillian L. Mariano. The panel fielded questions called in by the public concerning fishing and hunting regulations, management of Guam's fisheries, harvesting of Guam's marine resources, protection of fish and wildlife habitat and other related concerns.

(b) A two-hour appearance on Radio Station K-57's Dave Ecret Show by DAWR Herpetologist Michael J. McCoid. The topic of discussion was DAWR's position and role as an advisory body on the "Sweepsnakes" contest sponsored by the Guam Tribune, a thrice-weekly newspaper on Guam;

(c) A two-hour appearance on Radio Station K-57's Dave Ecret Show by DAWR Fisheries Section Supervisor Gerald W. Davis and staff from the University of Guam Marine Lab. Discussion centered on the reef damage at Sella Bay in Umatac as a result of runoff;

d) A half-hour feature on Guam Cable TV's "Tropical Vision", which focuses on the sport of hunting and Guam's hunting laws and regulations.

7. Purchase of professional display boards to replace two makeshift display boards.

8. Coordination of arrangements to create a DAWR display at the A. B. Won Pat International Airport. The display will feature non-importable products derived from protected, threatened, or endangered species. The U.S. Fish and Wildlife Service Forensic Lab has assured DAWR of its cooperation in providing such specimens.

9. Soliciting the cooperation of the Consul General of Korea in the translation of Guam's Fishing Laws and Regulations from Korean to English. The translation will result in the publication of a multi-lingual information pamphlet for distribution not only to shipping lines, tuna fishing boats, construction companies, tourists and airlines, but also the community in general.

10. Initiating a joint project between DAWR and the Commonwealth of the Northern Marianas (CNMI) Fish and Wildlife Division to create a travelling display of birdmounts for use in the PACE program. The display will be made up of forest birds native to Guam and the CNMI.

11. Continuation of library and school visits, primarily elementary and middle schools. In order to facilitate visitations to twice as many schools and to give students the opportunity to meet and thereby develop a respect for conservation officers and the role they play in the management and enforcement of Guam's endangered species, and fish and wildlife resources, the presentation format now includes at least one Conservation Officer. The wildlife presentation consists of a slide show on endangered species and game management, while the fish presentation consists of a 25-minute video tape on coral reef ecology and an overview of Guam's fishing laws and regulations. Presentations are complemented by a display of live and preserved animals, followed by a question-and-answer period.

12. Maintenance and exhibition of two static displays, one consisting of live Brown Tree Snakes complemented by a snake information board, the other complimented highlighting the impact of poaching on Guam's endangered species and fish and wildlife resources. Both displays were exhibited at the University of Guam's Charter Day festivities, Earth Week observance at the Micronesia Mall, the anniversary celebration of the War in the Pacific National Historical Park and the Micronesian

Cultural Fair at Ipao Beach Park. An estimated 8,000 to 10,000 schoolchildren and adults have viewed this display.

13. Participation at workshops, conferences, and programs including:

a) Volunteer Management Workshop (on-island) facilitated by USFWS Region 1 Education Coordinator, Mr. Fred Caslick;

b) Seafood Inspection Workshop (on-island);

c) Project Learning Tree Workshop at the University of Guam facilitated by the U.S. Forestry Service;

d) Wildbranch Workshop on Environmental Writing at Sterling College in Craftsbury Common, Vermont;

e) Brown Tree Snake Conference in Honolulu, Hawaii;

f) Panel member on Environmental Education, Teachers' Workshop, Price Elementary School;

g) On-island Fisherman's Forum conducted by the Western Pacific Fisheries Management Council;

h) On-island Resource Management Conference sponsored by the U.S. National Park Service; and

i) Hunter Education Workshop, Honolulu, Hawaii

14. Developing press releases and arranging press conferences focusing on DAWR's programs and activities;

15. Video documentation of all DAWR programs and activities including the endangered Guam Rail experimental population project on Rota, the deployment of five fish aggregating devices in Guam's waters; the snake-proofing of nesting sites for the endangered Marianas Crow, clearing of wildlife habitat for development projects, and others.

RECOMMENDATIONS

1. Continue fish and wildlife presentations at libraries and schools, both public and private, and other organizations.

2. Continue public awareness program through press releases, news articles, press conferences and other media to keep public informed of the progress and accomplishments of the Division's fish, wildlife and endangered species programs. The program should not only target Guam's local students and residents, but also H-2 workers, tourists and other transients.

3. Secure funding for printing of pending conservation education/information materials such as animal flyers, bumper stickers and posters, and develop other materials.

4. Coordinate the Division's participation in mutual programs and projects with Guam's Department of Education, CZM, Sea Grant, the University of Guam Extension

Service, Department of Parks and Recreation, and the Environmental Protection Agency.

5. Encourage the creation of an education/information network comprised of educators and resource persons from environmentally-oriented departments and agencies. This organization would serve not only as a resource group, but more importantly, as a developer of programs and activities to encourage public involvement and participation in environmental concerns. Such a network would be invaluable to Guam's increasingly multi-ethnic and culturally-diverse population. It would also go a long way towards assuring that this tiny Pacific island does not totally succumb environmentally or culturally, to the ill effects of massive uncontrolled and unplanned development.

6. Finalize plans to implement a Leadership Workshop for public and private school teachers. The workshop is a major component of DAWR's Aquatic Education plan.

Report prepared by: Lillian L. Mariano

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Offshore Fisheries Survey

PERIOD COVERED: October 1, 1989 to September 30, 1990.

SUMMARY

Monthly offshore fisheries surveys were conducted at the Agana Boat Basin and other boat launching locations along Guam's shoreline from October 1989 through September 1990. An islandwide finfish catch from small recreational-type vessels is estimated at 303.4 metric tons (m.t.) for that period. The bulk of the catch, 270.0 m.t., was landed by trolling during an estimated 60,427 boat-hours of effort. The bulk of the troll catch, 263.2 m.t., consisted of five major pelagic species. Bottomfishing produced an estimated 20.2 m.t., primarily snappers and emperors, and night-light jigging for atulai produced an estimated 2.6 m.t. Spearfishing produced 6.3 m.t. of finfishes and 1.1 m.t. of shellfish. Approximately 2.1 m.t. of finfish and 0.4 m.t. shellfish were caught by hand or gill net. Catches by infrequently encountered methods may be under-estimated as follows: bottomfishing (0.9 %); spearfishing (20 %); and other methods combined (14%).

BACKGROUND

Effective management of the island's offshore fishery resources requires accumulating data on fishing pressure, types of fishing methods used and annual harvest. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatic and Wildlife Resources (DAWR) has been monitoring offshore fishing activities for the past 13 years. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. Recently, however, major advances have been made in both field survey techniques and in the area of computerized statistical analysis. Much of this progress has resulted from the combined efforts of DAWR and National Marine Fisheries Service (NMFS) personnel through the Western Pacific Fisheries Information Network (WPACFIN) program (see Study F-1, Job 3).

OBJECTIVES

1. To quantify fishing participation, effort, and catch which occurs outside the reef margin in boats.

2. To collect biological data from the specimens examined during interviews.

PROCEDURES

During FY90, interviews of returning offshore fishing parties were conducted on four days each month at the Agana Boat Basin. Two of these days were randomly selected weekdays (WD) and two were randomly selected weekend days (WE/H, which, in this report,

includes holidays). Each survey consisted of two periods, one from 0500 to 1200 hours (previously to only 1100 hours) and the other from 1600 to 2400 hours. In addition, interviews from the southern launching site of Merizo Pier were obtained on one day per month, alternating between weekdays and weekends from the hours of 0600 to 1100 and 1600 to 2000. Islandwide participation was determined by means of a morning and evening survey of all public boat launching areas in which all trailers attached to vehicles were counted, but no interviews were taken. This assumes that the proportion of boat trips participating in fishing to boat trips not participating in fishing as well as the proportion of boats engaging in each method for boats utilizing the Agana Boat Basin is representative of the island as a whole.

Sampling and analytical procedures used in the GOES (Guam Offshore Expansion System) remain basically unchanged from those outlined in the FY85 annual report, with the following exceptions:

1. The changes implemented in response to observations of fishing activity during the three-day Guam International Fishing Derby (GIFD) remain the same as those outlined in the FY88 annual report. In addition, a two day Lion's Club derby in May attracted numerous additional non-charter boats, so it was determined that simply adding results for the non-charter component of the derby to the 31 day expansion would sufficiently address the problem. Therefore, the statistics for the month of July and for the year for trolling and bottomfishing are based on 28-day and 362-day expansions, respectively, with the GIFD and Lion's Club derby results added for trolling. Statistics for the remaining methods are based on 31-day and 365-day expansions for July and the year, respectively.*

2. The method used to assess the degree of under-sampling reflected in the GOES output for the FY85-88 annual reports assumes that there are no differences between WD and WE/H days, and in the case of spearfishing, assumes that there is no difference between scuba and snorkeling methods. Therefore, this method was modified to consider each of these potential differences separately by multiplying the average daily parameters of catch and effort separately for each method and day type by the correction factor, F where:

$$F = \frac{n(Po)}{Pi}$$

n = no. of days (WD or WE/H)

Po = the sum of boats known to participate in a given method for all days surveyed.

Pi = the sum of boats known to participate in a given method for days in which an interview was obtained.

RESULTS

Trolling

An estimated 270.0 m.t. of troll-caught fish were landed islandwide during FY90 (Table 1). Monthly catches ranged from a high of 35.9 m.t. in March to a low of 8.4 m.t. in January (Figure 1). An estimated 60,427 boat-hours were spent trolling with an average catch rate of 4.5 kg/boat-hour. Monthly catch rates as catch per unit of effort (CPUE), ranged from 3.1 kg/boat-hour in December to 8.6 kg/boat-hour in March.

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* Refer to the appendix for a detailed report on the GIFD.

Table 1. Estimated monthly and annual trolling participation, effort, and catch during FY90. Estimates include the GIFD. Weights are in kilograms (1 kg = 2.2 lbs).

A) PARTICIPATION:

MONTH	NO. OF PERSONS	SE	90% CL	NO. OF BOAT-TRIPS	SE	90% CL
OCT	3,330.1	283.5	667.0	954.3	89.9	211.6
NOV	4,987.2	539.1	1,268.6	1,451.0	88.1	207.3
DEC	4,798.8	1,091.6	2,568.5	1,423.2	308.9	726.7
JAN	3,465.1	591.0	1,390.5	689.6	116.8	274.9
FEB	5,359.5	314.1	739.0	1,140.6	104.4	245.7
MAR	3,342.2	595.8	1,401.8	910.0	294.9	693.8
APR	5,476.1	1,501.5	3,533.1	1,310.1	377.7	888.7
MAY*	4,749.4	954.1	2,245.0	1,122.4	260.0	611.7
JUN	5,388.4	417.5	982.5	1,053.8	99.4	233.8
JUL**	5,282.5	708.7	1,667.6	1,342.8	128.9	303.2
AUG	2,804.5	193.2	454.7	705.1	59.5	140.0
SEP***	4,112.7	409.2	962.8	1,116.8	114.6	269.7
TOTAL	53,096.5			13,219.7		
GOES	52,625.3	2,903.4	4,889.3	13,062.6	715.7	1,205.2

B) EFFORT:

MONTH	NO. OF PERSON-HOURS	SE	90% CL	NO. OF BOAT-HOURS	SE	90% CL
OCT	13,381.5	1,678.4	3,949.2	3,810.1	411.2	967.5
NOV	25,912.0	2,617.0	6,157.8	7,547.6	412.4	970.5
DEC	24,588.9	4,812.0	11,322.6	7,296.3	1,331.9	3,134.0
JAN	12,237.5	1,029.7	2,422.8	2,425.9	200.3	471.4
FEB	23,091.7	2,082.2	4,899.4	4,969.7	599.7	1,411.1
MAR	14,432.5	4,973.3	11,702.1	4,188.3	1,973.3	4,643.2
APR	26,087.7	7,917.8	18,630.6	6,458.5	2,289.9	5,388.1
MAY*	21,163.6	4,275.7	10,060.7	5,098.9	1,194.6	2,811.0
JUN	22,552.6	869.6	2,046.2	4,458.5	575.6	1,354.3
JUL**	29,195.6	3,332.3	7,840.7	7,395.0	567.2	1,334.7
AUG	11,409.0	1,008.3	2,372.5	2,940.4	607.0	1,428.3
SEP***	17,081.2	1,507.4	3,547.0	4,649.3	418.7	985.3
TOTAL	241,133.8			61,238.5		

C) CATCH:

MONTH	NO. OF KILOGRAMS	SE	90% CL	Kg/B-T	Kg/B-H	Kg/P-H
OCT	12,378.1	4,457.7	10,488.9	13.0	3.2	0.9
NOV	29,681.3	4,575.6	10,766.3	20.5	3.9	1.1
DEC	22,937.8	6,095.8	14,343.4	16.1	3.1	0.9
JAN	8,401.3	2,279.5	5,363.6	12.2	3.5	0.7
FEB	25,158.0	6,975.4	16,413.1	22.1	5.1	1.1
MAR	35,880.7	21,210.8	49,909.1	39.4	8.6	2.5
APR	27,391.2	11,064.7	26,035.2	20.9	4.2	1.0
MAY*	22,616.6	7,579.0	17,833.4	20.2	4.4	1.1
JUN	17,301.0	5,912.5	13,912.2	16.4	3.9	0.8
JUL**	25,043.6	2,953.4	6,949.4	18.7	3.4	0.9
AUG	24,783.0	8,793.6	20,691.4	35.1	8.4	2.2
SEP***	22,323.8	1,904.2	4,480.7	20.0	4.8	1.3
TOTAL	273,896.4			20.7	4.5	1.1
GOES	270,003.1	27,012.5	45,489.0	20.7	4.5	1.1

*Includes estimated participation, effort, and catch totals for a two-day Lion's Club derby added to the GOES 31 day expansion.
**Based on participation, effort, and catch totals for the GIFD added to the GOES 28 day expansion.
***Based entirely on the GOES 30 day expansion, disregarding a 3 day Z-Best derby since no catch or effort data was available.

The usual five pelagic species accounted for the bulk of the catch (96.1%; Table 2). Skipjack tuna (*Katsuwonus pelamis*; 24.4%) was the most highly caught, followed by blue marlin (*Makaira nigricans*; 21.5%), wahoo (*Acanthocybium solandri*; 21.4%), mahimahi (*Coryphaena hippurus*, 18.7%), and yellowfin tuna (*Thunnus albacares*; 10.1%). Scombrids collectively comprised 57.5% of the total trolling catch.

The troll fisheries catch of FY90 rebounded somewhat from the dramatic drops reported for FY89. The trolling catch was 33% higher than the 203 m.t. landed in FY89, but still 21% less than the historic high of 342 m.t. landed in FY88. However, it should be noted that statistically, at the 90% confidence level, the FY90 catch was not significantly different from either the FY88 or FY89 catches although the FY89 catch was significantly lower than the FY88 catch.

Estimated landings of all five of the major troll-caught species increased over those for FY89, with increases ranging from 27% for wahoo to 61% for yellowfin tuna. However, since it is not yet possible to calculate confidence intervals for catches of a given species, it is unknown if any of these increases is significant. It should be noted that the yellowfin tuna catch consisted nearly entirely of small immature fish. The catches of wahoo and blue marlin increased to new historic highs of 59 m.t. each (up 27% and 31%, respectively). Among the minor species, the catches of kawakawa (*Euthynnus affinis*) and sailfish (*Istiophorus platypterus*) increased by 1,253% and 98%, respectively, while catches of rainbow runner (*Elagatis bipinnulatus*) and barracuda (*Sphyraena barracuda*) decreased by 61% and 6%, respectively. The increased catch of many species may have been due to the deployment of five fish aggregating devices (FADs) in April. Small kawakawa and skipjack and yellowfin tunas were frequently landed in the vicinity of the FADs. However, it is not yet possible to give a breakdown of FAD-caught vs. non-FAD-caught fishes or to determine in any specific way the effectiveness of the FADs.

The increase in landings between FY89-90 may be explained primarily by increases in participation and effort, since catch rates remained about the same, at 20.7 kg/boat trip (up 12%), 4.5 kg/boat-hour (up 6%), and 1.1 kg/person-hour (down 6%), respectively. The time spent fishing as measured by person-hours and boat-hours, increased to 238,665 (39%) and 60,427 (25%), respectively. The number of boat trips and person-trips increased to 13,063 (19%) and 52,625 (33%), respectively.

All estimates of participation and effort increased since FY89 to exceed the previous all-time highs of FY88. However, differences in participation were barely not significantly different at the 90% level from those of FY89 or FY88. Effort as person-trips was significantly greater in FY90 than in either FY88 or FY89, while effort as person-hours was significantly greater than in FY89, but not FY88. The greater effort in terms of persons and person hours is most likely a reflection of the rapidly expanding charter fishing industry in which more people participate in more numerous but shorter trips.

Bottomfishing

An estimated 20.2 m.t. of bottomfishes were landed islandwide during FY90 (Table 3). Estimated monthly catches ranged from a high of 3.7 m.t. in September to a low of 53 kg. in January. Bottomfish landings fluctuated widely, with generally poorer catches from

Table 2. Monthly and annual composition of the Guam trolling catch during FY90. Estimated weights are in kilograms and include the GIFD. A + indicates less than 0.05% of the annual catch.

Family and Species	Oct	Nov	Dec	Jan'90	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	total	% of total
Belonidae														
Ablennes hians			55.7										55	+
Tylosurus crocodilus											135.2		135	+
Carangidae														+
Carangoides plagiotaenia									2.4				2	+
Caranx ignobilis						133.2							133	+
Caranx melampygus							11.4						11	+
Elagatis bipinnulatus	69.1	40.2		36.3	57.7	36.5	66.5	182.6	30.2	24.3	17.4	34.0	594	0.2
Scomeroides lysan						17.3				10.0			27	+
Selar crumenophthalmus												5.1	5	+
Coryphaenidae														
Coryphaena hippurus	666.1	196.5	7,620.5	3,979.6	17,003.3	10,905.6	7,296.7	1,510.9	701.6	298.6	193.2	813.4	51,186	18.7
Lutjanidae														
Aphareus furca							53.7		2.9				56	+
Aprion virescens		34.2											34	+
Lujanus bohar						109.4				57.3			166	0.1
Spyraenidae														
Sphyraena barracuda	393.3	628.4	391.5	72.5	24.0	521.7	30.7	339.9	90.1	159.2	19.3	113.4	2,784	1.0
Sphyraena genie							275.1		44.0				319	0.1
Scombridae														
Acanthocybium solandri	2,264.6	25,197.4	8,972.3	1,252.9	2,422.8	12,309.9	1,891.6	2,593.5	257.2	511.2	131.4	881.5	58,686	21.4
Euthynnus affinis	245.5	437.9	187.4	407.5	79.9	85.0	99.7	49.6	9.9	417.4	892.2	687.8	3,599	1.3
Grammatorcynos bilineatus							11.1			17.4		16.2	44	+
Gymnosarda unicolor					61.3	117.5	252.4	133.0		8.1	297.5		869	0.3
Katsuwonus pelamis	2,848.7	2,728.0	5,237.3	2,232.1	1,912.7	6,765.2	6,240.9	4,903.0	3,328.8	5,669.6	15,439.8	9,410.7	66,716	24.4
Thunnus albacares	1,335.3	418.7	473.2	420.4	1,831.4	1,479.3	5,605.0	4,816.0	2,315.6	2,227.4	1,611.0	5,166.7	27,700	10.1
Istiophoridae														
Istiophorus platypterus						674.9				29.9		1,134.3	1,839	0.7
Makaira nigricans	4,555.4				1,764.8	2,725.2	5,556.3	8,088.1	10,518.4	15,613.1	6,046.1	4,060.6	58,928	21.5
Total	12,378.1	29,681.3	22,937.8	8,401.3	25,158.0	35,880.7	27,391.2	22,616.6	17,301.1	25,043.6	24,783.0	22,323.8	273,896	100.0

January to April. An estimated 26,034 person-hours were spent during 9,139 boat-hours of bottomfishing, resulting in an overall catch rate of 2.2 kg/boat-hour. Monthly catch rates ranged from 0.4 kg/boat-hour in January to 3.4 kg/boat-hour in March.

Table 3. Estimated monthly and annual Guam bottomfishing participation, effort, and catch during FY90.

A) PARTICIPATION:

MONTH	NO. OF PERSONS	SE	90% CL	NO. OF BOAT-TRIPS	SE	90% CL
OCT	699.1	261.4	615.2	224.6	68.9	162.2
NOV	522.8	212.4	499.8	176.1	64.8	152.5
DEC	671.9	77.4	182.1	220.9	23.1	54.4
JAN	261.2	185.6	436.7	69.4	51.4	120.9
FEB	263.2	59.2	139.3	94.0	51.5	121.2
MAR	298.1	217.8	512.5	96.0	71.8	169.0
APR	659.0	180.5	424.7	201.2	36.0	84.6
MAY	1,040.4	222.7	524.1	359.8	33.2	78.2
JUN	446.2	250.6	589.7	171.9	89.0	209.5
JUL*	816.1	420.0	988.2	281.0	109.3	257.1
AUG	264.0	181.3	426.6	80.5	51.8	121.9
SEP	794.5	133.8	314.9	314.2	38.6	90.8
TOTAL	6,736.5			2,289.6		
GOES	6,592.3	790.4	1,331.0	2,243.3	245.3	423.1

B) EFFORT:

MONTH	NO. OF PERSON-HOURS	SE	90% CL	NO. OF BOAT-HOURS	SE	90% CL
OCT	2,512.8	1,020.7	2,401.7	818.9	278.3	654.9
NOV	1,659.7	284.2	668.7	580.0	129.9	305.8
DEC	1,922.3	350.2	824.1	680.1	197.7	465.2
JAN	487.8	318.3	749.0	123.8	81.9	192.8
FEB	1,076.8	603.9	1,420.9	442.1	327.1	769.6
MAR	1,289.1	965.3	2,271.3	419.0	319.1	750.8
APR	2,158.3	413.5	972.9	674.4	63.0	148.1
MAY	4,955.7	1,676.1	3,943.8	1,651.8	304.9	717.4
JUN	2,074.5	1,120.9	2,637.5	832.7	442.2	1,040.4
JUL*	4,158.4	1,656.0	3,896.6	1,486.8	383.0	901.3
AUG	619.1	272.9	642.2	201.6	77.6	182.6
SEP	3,311.0	344.9	811.5	1,280.9	108.5	255.4
TOTAL	26,225.5			9,192.1		
GOES	26,034.5	3,507.3	5,906.3	9,139.2	1,101.6	1,855.1

C) CATCH:

MONTH	NO. OF KILOGRAMS	SE	90% CL	Kg/B-T	Kg/B-H	Kg/P-H
OCT	1,538.6	642.6	1,512.0	6.9	1.9	0.6
NOV	945.0	257.0	604.8	5.4	1.6	0.6
DEC	1,547.1	631.7	1,486.5	7.0	2.3	0.8
JAN	53.1	47.5	111.7	0.8	0.4	0.1
FEB	578.9	455.6	1,071.9	6.2	1.3	0.5
MAR	1,416.6	1,039.4	2,445.8	14.8	3.4	1.1
APR	1,567.9	837.1	1,969.8	7.8	2.3	0.7
MAY	3,177.4	1,333.2	3,137.1	8.8	1.9	0.6
JUN	1,973.0	868.9	2,044.4	11.5	2.4	1.0
JUL*	3,291.6	1,285.2	3,024.0	11.7	2.2	0.8
AUG	463.6	327.6	770.8	5.8	2.3	0.7

SEP	3,728.0	1,298.7	3,055.8	11.9	2.9	1.1
TOTAL	20,280.8			8.9	2.2	0.8
GOES**	20,241.2	2,979.3	5,017.1	9.0	2.2	0.8

*Results are based on a 28 day expansion on the assumption that bottomfishing was negligible during the three day GIFD.

**Results are based on a 362 day expansion based on the assumption that bottomfishing was negligible during the three day GIFD.

The estimated bottomfishing catch for FY90 was 17% lower than that of FY89. However, this is not significant at the 90% level, and all measures of participation and effort for FY90 remain virtually unchanged from those of FY88-89.

The composition of FY90 bottomfish catch was also very similar to that of recent years, with snappers (Lutjanidae) and emperors (Lethrinidae) accounting for 39% and 28% of the weight landed, respectively (Table 4). The most important snappers were the uku (*Aprion virescens*; 1.7 m.t.), a shallow species that ranges into deeper water; followed by the deepwater yellowtail kalikali (*Pristipomiodes auricilla*, 1.4 m.t.), gindai (*P. zonatus*; 0.9 m.t.), lehi (*Aphareus rutilans*; 0.6 m.t.), onaga (*Etelis coruscans*, 0.6 m.t.), opakapaka (*P. filamentosus*; 0.5 m.t.), ehu (*E. carbunculus*; 0.4 m.t.), and yellow-eye opakapaka (*P. flavipinnis*; 0.4 m.t.); funai (*Lutjanus kasmira*; 0.3 m. t.), a shallow water species that ranges into deep water, and red snapper (tagafe; *Lutjanus bohar*, 0.2 m.t.), a relatively shallow water species. The emperor catch consisted primarily of the redgilled emperor (*Lethrinus rubrioperculatus*, 4.0 m.t.) which remained the single most important bottomfish species, comprising 21% of the overall bottomfishing catch and 74% of the emperor catch. As in FY88, groupers (Serranidae; 2.1 m.t.) ranked third in importance (11%) with two species (*Epinephelus fasciatus*; 0.6 m.t.) and *Variola louti*; 0.7 m.t.) predominating. Other important families included the jacks (Carangidae; 8%), requiem sharks (Carcharhinidae; 4%), wrasses (Labridae; 3%), squirrelfishes (Holocentridae; 2%). and goatfishes (Mullidae; 2%).

Table 4. Composition of the Guam bottomfishing catch during FY90. Estimated weights are in kilograms. Percentages are based on the differentiated portion of the catch only. The data is based on a 362 day expansion which assumes that bottomfishing activity was negligible during the three day GIFD.

	Shallow Species		Deep Species		Total	
FAMILY	Weight	%	Weight	%	Weight	%
Carcharhinidae (Requiem sharks)	852.3	6.2			852.3	4.3
Exocoetidae (Flyingfishes)	1.8	0.0			1.8	0.0
Synodontidae (Lizardfishes)	2.5	0.0			2.5	0.0
Holocentridae (Squirrelfishes)	362.2	2.6			362.2	1.9
Scorpaenidae (Scorpionfishes)			7.7	0.1	7.7	0.0
Serranidae (Groupers)	1,875.5	13.6	195.4	3.4	2,070.9	10.6
Priacanthidae (Bigeyes)	47.5	0.3			47.5	0.2
Apogonidae (Cardinalfishes)	2.7	0.0			2.7	0.0
Malacanthidae (Sand tilefishes)	3.6	0.0			3.6	0.0
Carangidae (Jack)	1,078.5	7.8	565.9	9.8	1,644.4	8.4
Coryphaenidae (Mahimahi)	53.2	0.4			53.2	0.3
Lutjanidae (Snappers)	2,701.4	19.5	4,940.7	85.5	7,642.1	39.0
Lethrinidae (Emperors)	5,492.4	39.7			5,492.4	28.0
Mullidae (Goatfishes)	313.0	2.3	12.3	0.2	325.3	1.7

Pempheridídae (Sweepers)	33.3	0.2			33.3	0.2
Sphyraenidae (Barracudas)	144.9	1.0			144.9	0.7
Labridae (Wrasses)	566.7	4.1			566.7	2.9
Pinguipedidae (Sand perches)	1.2	0.0			1.2	0.0
Acanthuridae (Nasinae: unicornist	79.0	0.6			79.0	0.4
Gempylidae (Snake mackerels)			12.8	0.2	12.8	0.1
Scombridae (Tunas)	77.3	0.6			77.3	0.4
Balistidae (Triggerfishes)	152.1	1.1	9.1	0.2	161.2	0.8
Triodontidae (Tripletooth)			32.1	0.6	32.1	0.2
SUBTOTAL	13,841.1	100.0	5,776.0	100.0	19,617.1	100.0
Undifferentiated	623.5	4.3			623.5	3.1
TOTAL	14,464.6	71.5	5,776.0	28.5	20,240.6	100.0

Relatively shallow water species (found primarily at depths of 150 m or less) comprised more than twice as much of the catch (14.5 m.t. or 72%) as did deeper water species (found primarily below 150 m; 5.8 m.t. or 29%). The continued importance of small species with high turnover rates at shallow to moderate depths (e.g. *Lethrinus rubrioperculatus* and *Epinephelus fasciatus*), is indicative of a heavily-fished resource. However, relatively steady CPUEs indicate that the fishery is stable at current levels of participation. Unchecked increases in participation could result in significantly lower CPUEs and catches in the future. Since the GOES does not distinguish between shallow and deep effort, it is not yet possible to calculate separate statistics for participation or effort for shallow and deepwater bottomfish fisheries.

Spearfishing

The estimated monthly and annual participation, effort, and catch for spearfishing from boats during FY90 are summarized in Tables 5 and 6. (Readers should also refer to Study F-1, Job 2 for estimates of spearing from shore, i.e., without the use of boats, to gain a more complete picture of FY90 spearfishing activities on Guam.)

An estimated 8.0 m.t. of speared fish, crustaceans, and mollusks were landed from boats during FY90, slightly lower than the catches of FY88-89 (15% less than the historic high catch of 11.9 m.t. in FY88). The bulk of effort remained by snorkeling rather than scuba diving (782 vs. 474 boat hours), but only slightly more of the catch was by that method (3.9 m.t. snorkeling vs. 3.6 m.t. using scuba). The average catch rate for spearfishing in FY90 was approximately 6.0 kg/boat-hour, 25% higher than last year's rate but slightly lower than those of FY85-87. However, it is highly unlikely that any of these differences between recent years is significant at even the 90% level of confidence. It is not possible to obtain confidence limits for overall spearfishing statistics since each component of snorkel, scuba, and mixed are expanded separately. However, the 90% CL for each of these components indicates that none of the differences between recent years cited above is significant. It may not be possible to detect differences between years, even if they do exist, at the current level of sampling since spearfishing is an uncommonly encountered method. Since some spearfishing parties return late at night outside our survey period and the GOES only considers complete interviews, we also believe that the above estimates are low. Based on days in which participation in spearfishing occurred, but interviews were not obtained, it is believed that the GOES expansion for FY90 underestimates the spearfishing catch by approximately 20%.

Table 5. Estimated monthly and annual offshore spearfishing (with and without scuba) participation, effort, and catch during FY90.

	PARTICIPATION	EFFORT		CATCH				
MONTH	no. of Persons	no. of Boat trips	no. of Person-hrs	no. of Boat-hrs	no. of Kilograms	Kg/ boat trip	Kg/ pers-hr	Kg/ boat-hr
OCT	163.6	57.8	310.5	106.8	545.8	9.4	1.8	5.1
NOV	76.5	25.5	153.0	51.0	382.6	15.0	2.5	7.5
DEC	229.8	76.0	268.1	87.1	232.8	3.1	0.9	2.7
JAN	51.2	12.8	51.2	12.8	46.4	3.6	0.9	3.6
FEB	170.6	66.3	354.4	128.6	541.2	8.2	1.5	4.2
MAR	155.7	64.3	303.4	113.6	595.0	9.3	2.0	5.2
APR	24.2	16.1	21.2	14.1	690.1	42.9	32.6	48.9
MAY	230.5	59.8	552.1	400.4	184.7	3.1	0.3	0.5
JUN	188.0	52.4	428.7	158.9	693.0	13.2	1.6	4.4
JUL	789.4	160.3	2,384.3	433.5	3,657.9	22.8	1.5	8.4
AUG	80.2	26.7	80.2	26.7	108.0	4.0	1.4	4.0
SEP	17.3	17.3	4.3	4.3	0.0	0.0	0.0	0.0
TOTAL	2,177.0	635.3	4,911.4	1,537.8	7,677.5	12.1	1.6	5.0
GOES	2,210.0	646.6	5,230.0	1,333.9	7,981.4	12.3	1.5	6.0

Table 6. Estimated annual Guam offshore spearfishing participation, effort, and catch by method during FY90.

A) PARTICIPATION:	No. of persons	SE	90% CL	No. of Boats	SE	90% CL
	1,171.3	513.8	865.3	299.3	96.2	162.1
	903.8	224.2	377.5	308.0	75.0	126.4
	134.9	78.5	132.2	39.3	24.7	41.6
Total Spearfishing	2,210.0	816.5	1,375.0	646.6	195.9	330.1

B) EFFORT:	Person hours	SE	90% CL	Boat hours	SE	90% CL
	3,539.8	1,978.8	3,332.2	781.8	346.1	582.9
	1,438.6	359.6	605.6	473.9	116.3	195.9
	251.6	149.0	250.9	78.2	49.1	82.6
Total Spearfishing	5,230.0	2,487.4	4,188.7	1,333.9	511.5	861.4

C) CATCH:	No. of Kilograms	SE	90% CL	Kg/ boat trip	Kg/ pers.-hr	Kg/ boat-hr
	3,888.7	2,366.6	3,985.3	12.99	1.1	5.0
	3,589.0	920.9	1,550.9	11.65	2.5	7.6
	503.5	286.3	482.1	12.81	2.0	6.4
Total Spearfishing	7,981.2	3,573.8	6,018.3	12.34	1.5	6.0

As in previous years, surgeonfishes (Acanthuridae; 30%), parrotfishes (Scaridae; 24%), and wrasses (Labridae; 22%) dominated the FY90 spearfishing finfish catch (Table 7). However, the order of importance shifted between families (parrotfishes and surgeonfishes were first and second, respectively in FY89). Groupers (Serranidae; 6%) were fourth in importance, followed by sweetlips (Haemulidae; 4%), rabbitfishes (Siganidae; 3%),

rudderfishes (Kyphosidae; 2%) goatfishes (Mullidae; 2%), snappers (Lutjanidae; 2%), emperors (Lethrinidae; 2%), jacks (carangidae; 1%), and squirrelfishes (Holocentridae; 1%).

Table 7. Composition of the Guam spearfishing catch during FY90. Percentages of finfishes by family are of the differentiated portion of the catch only.

	SNORKEL		SCUBA		MIXED		TOTAL	
TAXON	Kg.	%	Kg.	%	Kg.	%	Kg	%
FISHES								
Holocentridae (Squirrelfishes)	63.5	2.3	14.6	0.5			78.1	1.2
Serranidae (Groupers)	57.0	2.1	312.2	10.0			369.2	5.9
Carangidae (Jacks)	46.5	1.7	34.8	1.1			81.3	1.3
Lutjanidae (Snappers)	40.7	1.5	45.8	1.5	30.7	6.4	117.2	1.9
Caesionidae (Fusiliers)			6.2	0.2			6.2	0.1
Haemulidae (Sweetlips)			258.0	8.3			258.0	4.1
Lethrinidae (Emperors)	53.6	2.0	56.7	1.8			110.3	1.7
Mullidae (Goatfishes)	104.9	3.9	14.7	0.5			119.6	1.9
Kyphosidae (Rudderfishes)	127.1	4.7	8.4	0.3			135.5	2.1
Labridae (Wrasses)	82.3	3.0	884.9	28.4	397.9	82.9	1,365.1	21.6
Scaridae (Parrotfishes)	841.7	31.0	634.5	20.4	30.9	6.4	1,507.1	23.9
Acanthuridae (Surgeonfishes)	1,170.7	43.1	705.3	22.6	20.4	4.3	1,896.4	30.0
Siganidae (Rabbitfishes)	25.9	1.0	135.7	4.4			161.6	2.6
Bothidae (Flounders)			5.8	0.2			5.8	0.1
Balistidae (Triggerfishes)	47.3	1.7					47.3	0.7
Monacanthidae (Filefishes)	9.4	0.3					9.4	0.1
Diodontidae (Porcupinefishes)	42.9	1.6					42.9	0.7
Differentiated fishes subtotal	2,713.5	91.5	3,117.6	90.0	479.9	100.0	6,311.0	91.3
Undifferentiated fishes	253.3	8.5	347.8	10.0			601.1	8.7
Fishes subtotal	2,966.8	76.3	3,465.4	96.6	479.9	95.4	6,912.1	86.6
INVERTEBRATES								
Gastropods	195.3	21.2					195.3	18.3
Bivalves	585.5	63.5					585.5	54.8
Cephalopods	41.5	4.5	17.4	14.1	7.3	31.2	66.2	6.2
Spiny lobsters	55.4	6.0	80.8	65.4	9.3	39.7	145.5	13.6
Slipper lobsters	24.4	2.6	5.9	4.8			30.3	2.8
Crabs	19.5	2.1	19.5	15.8	6.8	29.1	45.8	4.3
Invertebrate subtotal	921.6	23.7	123.6	3.4	23.4	4.6	1,068.6	13.4
TOTAL (All species)	3,888.4	100.0	3,589.0	100.0	503.3	100.0	7,980.7	100.0

Other families each comprising less than 1% of the finfish catch included fusiliers (Caesionidae), flounders (Bothidae), triggerfishes (Balistidae), filefishes (Monacanthidae), and porcupinefishes (Diodontidae). In addition to fishes, an estimated 1.1 m.t. (15% of the catch) of mollusks (primarily the clam, *Tridacna maxima*) and crustaceans (primarily

spiny lobsters, mainly *Panulirus penicillatus*) were harvested by spearfishing parties during FY90.

Atulai Night-Light Jigging

Atulai (*Selar crumenophthalmus*) fishing was encountered during the months of October, November, March through May, July, and September.

An estimated 2.6 m.t. of fishes were landed by night-light jigging during 1,489 boat-hours of effort in FY90. Most of this consisted of atulai (*Selar crumenophthalmus*; 1.9 m.t., 71%) and the remaining incidental catch consisted of jacks (Carangidae; 0.3 m.t., 13%), dogtooth tuna (*Gymnosarda unicolor*, 0.1 m.t.; 3.1%), and negligible quantities of snappers (Lutjanidae), emperors (Lethrinidae), barracudas (Sphyraenidae), squirrelfishes (Holocentridae), bigeyes (Priacanthidae), goatfishes (Mullidae), and sweepers (Pempheridae).

This was the smallest estimated atulai catch of recent years, only a tenth that of the record 24 m.t. catch estimate of the previous year, but not much different from the estimated catches of FY87-88. This was the result of precipitous declines in estimated participation (63%) and effort (64%) combined with a greater decline in CPUE (70%; 1.8 kg/boat-hour vs. 5.8 kg/boat-hour in FY89). These differences are all significant at the 90% confidence level. It seems unlikely that differences of this magnitude could have resulted entirely from the frequency of sampling or by chance. Several additional factors should be considered, including a shift in participation from the Agana Boat Basin to other landing sites, poorer weather on the best nights for the fishery, and less interest in the fishery due to socio-economic factors. Random factors that could have caused the observed differences include not sampling on the best days for the fishery, based on moon phase and weather. A comparison of the moon phases of survey days between years would be useful for determining if the observed differences are due primarily to sample design. For the first time in the survey, interviews were obtained on every day this method was encountered, indicating that the GOES did not under-sample the fishery based on observed participation.

Other Methods

Other rarely encountered methods during FY90 included gill-netting, spin-casting from an anchored boat, and by hand (the latter method may utilize a knife or hand tool or no equipment at all). Together, they produced an estimated catch of 2.5 m.t., (2.1 m.t. of finfishes and 0.4 m.t. of topshell, *Trochus niloticus*) during 670 boat-hours of effort. It is believed that the GOES underestimated the combined catch of these methods by ~14%.

Overview

Including the GIFD, an estimated 303.4 m.t. (90% confidence limit [CL] $\leq$ 60.3 m.t.) of finfish (301.9 m.t.) and shellfish (1.5 m.t.) were landed islandwide by boats utilizing a variety of methods beyond the reef margin during FY90. An estimated 16,411 boat trips (CL $\leq$ 2,191) were made in which 275,797 person-hours (CL $\leq$ 38,114) were spent during 73,059 boat-hours of fishing (CL $\leq$ 10,698). Excluding the GIFD, the average daily participation is estimated at 26.1 boat trips per weekday and 67.1 boat trips per weekend day or holiday, both all-time highs and slightly higher than those of the last two years.

Excluding fishing derbies, overall monthly catch rates (kg/boat-hour) ranged from 3.1 kg/boat-hour in October to 8.0 kg/boat-hour in August with an annual average of 4.2 kg/boat-hour, (20% lower than that of FY89). Including the Lion's Club derby and GIFD, trolling accounted for 89.0% of the FY90 catch (270.0 m.t., 90% CL = 45.5 m.t.), bottomfishing

comprised 6.7% of the catch (20.2 m.t.; 90% CL = 5.0 m.t.), spearfishing accounted for 2.6% (8.0 m.t.; 90% CL = 6.0 m.t.) of the catch, night-light jigging for atulai accounted for 0.9% of the catch (2.6 m.t.; 90% CL = 2.0 m.t.), and other rare methods accounted for 0.8% (2.5 m.t.) of the catch.

The estimated trolling catch increased over that of FY89, but was still slightly lower than the all time high of FY88, but CPUE remained about the same, about 30% below the high catch rate of FY88. The increased catch was due to increases in participation and effort between FY89-90. Much of this was due to increased charter fishing activity.

The FY90 bottomfishing catch remained essentially unchanged from that of the past two years while the spearfishing catch appeared to have continued to slowly decline. CPUEs for bottomfishing and spearfishing which had been declining since FY85, remained at approximately the same levels for the past four years while participation has leveled off after having doubled between FY87-88. Although relatively steady CPUEs indicate that these fisheries are stable at current levels of participation, unchecked increases in participation could result in significantly lower CPUEs and catches in the future. There is little doubt that the high levels of boating and fishing activity of the last three years is the result of Guam's current economic boom and rapid development and that these levels will remain high or increase as long as the economy is healthy.

The FY90 estimated atulai catch was the smallest in recent years, less than a tenth that of the record catch of FY89, but not much different from those of FY87-88. Although estimates of participation and effort were also significantly lower, than those of FY89, CPUE declined by 70%. A combination of factors, including the sample design itself, are likely causes for the wide fluctuations in the survey results.

RECOMMENDATIONS

There is little doubt that the reliability of estimates of islandwide catch and effort, based on the present survey, is limited by the quality of participation data taken at sites other than the Agana Boat Basin under the assumption that activity as well as catches landed there are representative of the island as a whole. However, data collected at Merizo Pier during FY89-90 indicates that this is not the case, but that there is proportionately much less trolling activity and much more bottomfishing, spearfishing, and gill net activity occurring there. We still do not have a clear idea how much boating participation takes place from less accessible landings (e.g.the private Achang Bay Marina), nor do we know the proportionality of the various methods at these areas. Islandwide estimates for the past several years are therefore disproportionately high for trolling, but low for other methods. Since these other methods are the only ones that are locally manageable, it is imperative that the survey results be unbiased as well as based on an adequate sample of interviews from launch sites other than the Agana Boat Basin. Separate expansions for the Agana Boat Basin and other boat launching sites will be desirable. It will also be necessary to reassess annual islandwide estimates of catch and effort as far back as possible.

Since all major trolling species have broadly distributed stocks, some of which are believed to be Pacific-wide, meaningful management and conservation of these resources will only be possible by international regional cooperation. This will require that databases be made available from as many sources and areas as possible, and that any biological assessment is based on adequate region-wide data. There are presently few areas from which adequate data on recreational or subsistence fisheries are available, significant gaps in the data for both foreign and domestic distant-water fisheries, and virtually no information on the interaction of recreational and large-scale commercial fisheries. It is therefore essential that the current time-series of data from Guam be maintained. Since Guam's recreational troll

fishery is incapable of taking more than a fraction of a percent of these stocks and could not have an adverse effect on them, and since the activities of both domestic and foreign large-scale commercial fisheries can significantly affect the performance of Guam's recreational fishery, it is imperative that Guam's recreational fisheries interests be represented and protected in any regional forum.

In order to effectively manage those fisheries that are specific to Guam, or to Guam and nearby islands and banks, additional biological information is needed on major bottom- and spearfished species. The offshore survey is currently too infrequent to obtain sufficient data to perform certain length-based analyses of any of these species. It is recommended that separate studies of the major bottomfish species be implemented that examine reproduction and ecology as well as length-frequency distributions. Comparisons with the inshore survey will have to be made to determine which spearfished species require further study.

The following projects have been proposed or implemented:

1) The GOES program will be rewritten and modified for use on the data base software "4th Dimension" on the fishery section's Macintosh SE/30 computer system. Dr. Steven Amesbury of the University of Guam Marine Laboratory is currently under contract to prepare the new GOES program. Modifications expected in the GOES will: (1) enable the program to produce more accurate expansions that factor in days in which a given method occurred but no interviews were obtained; (2) produce separate estimates for shallow and deepwater bottomfisheries; and (3) use additional location codes to more accurately distinguish between trips that include or exclude offshore banks. The software and hardware itself will greatly reduce the time needed to produce expansions as well as greatly reduce risks of input or transcription errors by making it possible to save subsets and files without having to re-enter variables, and by eliminating the need for dumping compiled summary data on other software in order to produce tables and charts. This will make it possible to quickly and efficiently examine many aspects of the data base that are impractical to examine under the current system as well as make it possible to re-expand the historic data base using more accurate information on participation.

2) A proposal has been submitted to the Western Pacific Regional Fisheries Management Council (Council) to fund a separate, intensive study of Islandwide participation in small-boat fisheries on a method and area-specific basis in order to produce more accurate islandwide expansions.

3) The Council is currently seeking funding for a number of projects that seek to obtain and analyze data on large-scale domestic and foreign fisheries of pelagic species that must be managed on a region-wide basis.

4) Studies of the major bottomfish species *Epinephelus fasciatus*, *Variola louti*, and *Lethrinus rubrioperculatus* that examine reproduction and ecology as well as length-frequency distributions will be initiated under the D-J funded project "Studies of Recreationally Important Reef Fish" (Project No. FW-2R Job F-1).

Therefore, we recommend that this job be continued, that sampling techniques continue to be refined or expanded as necessary, and that historic annual estimates of catch and effort be reassessed. We also recommend that staff fisheries biologists continue to work closely with NMFS personnel in improving the efficiency and accuracy of our computerized data analyses techniques, and that they take an active role in regional management activities through the Council and other regional organizations.

Report prepared by: Robert F. Myers

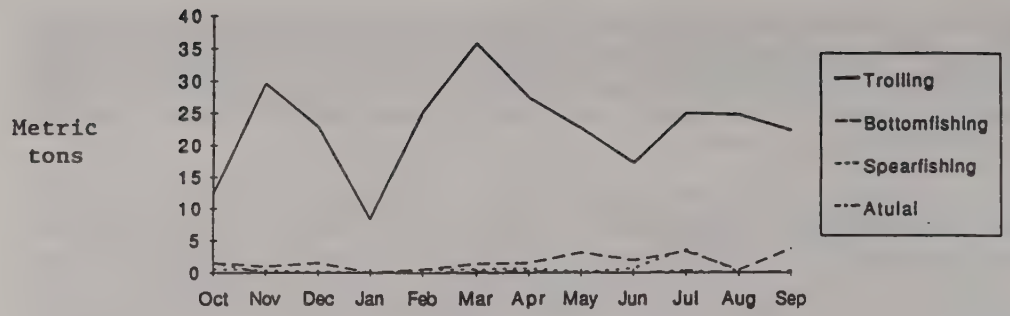
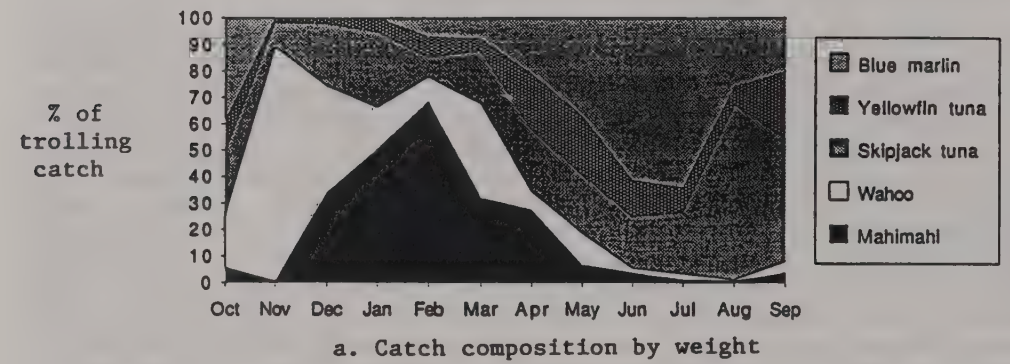


Figure 1. Estimated monthly landings for Guam small-boat offshore fisheries during FY 90.



a. Catch composition by weight

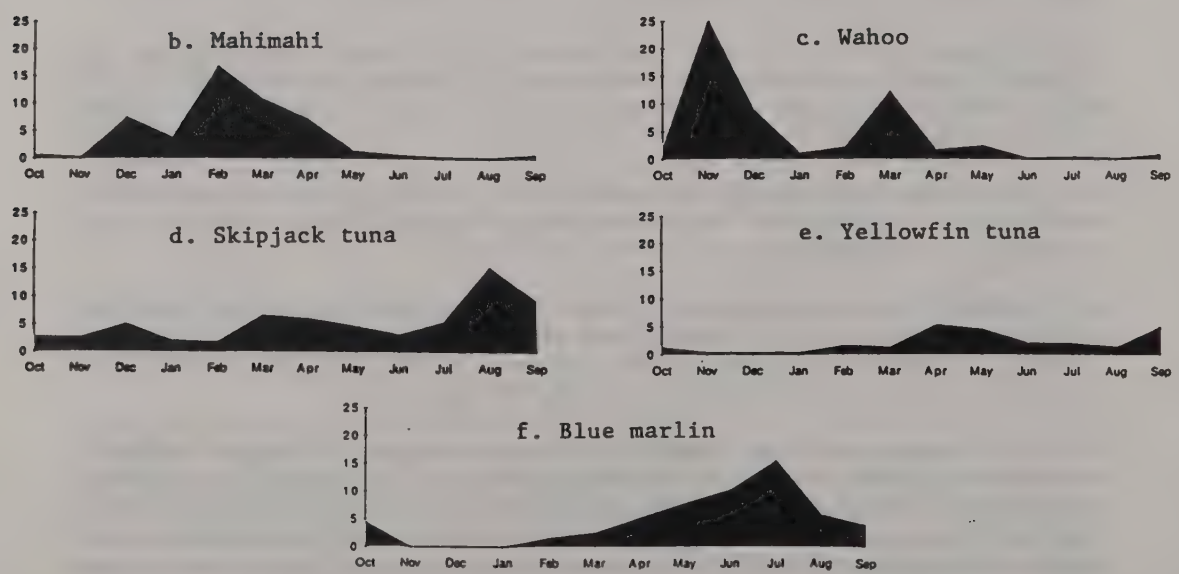


Figure 2. Estimated monthly landings for Guam's major trolling species during FY 90. All figures except 2a are in metric tons.

APPENDIX 1

Guam International Fishing Derby

PERIOD COVERED: July 6, 7, and 8, 1990

INTRODUCTION

The fourteenth Guam International Fishing Derby (GIFD), sponsored by the Guam Visitors Bureau (GVB), was held on July 6, 7, and 8, 1990. Awards were presented to the anglers who landed the first, second, and third heaviest fishes of the following species: blue marlin *(Makaira nigricans)*, yellowfin tuna *(Thunnus albacares)*, wahoo *(Acanthocybium solandri)* and mahimahi *(Coryphaena hippurus)*. As in the past derbies, awards were also given for the largest fish caught in a ladies category, and in a children under age 16 category. However, unlike the past several years, there was not an award given for the greatest 3-day total number of fish caught in the above categories combined. Records were kept in an "other species" category by the Division of Aquatic and Wildlife Resources (DAWR).

PROCEDURES

In theory, the determination of GIFD statistics is based on complete catch reports from all participating boats and requires no expansion, but in practice, there is always a significant number of boats that do not provide catch information. Since the Guam Offshore Expansion System (GOES) Tournament Module requires a complete data set, it has not been used, and the estimated derby parameters were added to the GOES monthly and annual output by hand.

DAWR biologists were present at the single onshore check-out/check-in station at the Agana Boat Basin. Merizo Pier was not included in the GIFD due to logistic constraints and safety considerations. A log of all departing and returning boats was kept and as many returning boats as possible were intercepted for interviews.

Parameters of participation and effort were determined by using daily averages in place of missing data wherever possible. This was done for number of fishermen, number of lines fished, and "down time" when determining hours spent fishing. For these parameters, daily data was missing for approximately 22 to 48% of returning boats, depending on the parameter and day. The number of boat trips and boat hours was known since a log of all departing and returning boats was kept.

Determination of catches required a subjective appraisal of what species were likely to be present in non-intercepted boats. Average daily catch rates by species were assigned to non-intercepted boats in order to determine daily totals. Catches of non-intercepted boats were assumed to contain only non-derby species. The proportion of returning boats intercepted ranged from 67% on the first day to 79% on the last day of the derby.

RESULTS

Participation

A record of 123 boats made 322 fishing trips during the course of the derby. This was a 99% increase in the number of boats and 75% increase from the relatively low number of

trips made during last year's derby. There was an average of 3.5 anglers pulling an average of 3.9 lines per trip. The mean time spent on the water was 8.6 hours per boat trip, of which 8.2 hours were spent fishing. These figures are essentially unchanged from those of the last two years (Table 1).

Table 1. Daily participation, effort, and catch in the fourteenth annual Guam International Fishing Derby (6-8 July). Weights are expressed in kilograms (1kg=2.2lbs).

	DAY 1	DAY 2	DAY 3	DERBY TOTALS
# Boats	85.0	101.0	91.0	123.0
# Boat Trips	94.0	115.0	113.0	322.0
# Fishermen*	280.0	349.0	331.0	960.0
Avg. # Fishermen/Boat	3.3	3.5	3.6	3.5
# Lines Fished**	368.1	374.7	324.0	1,066.8
Avg. # Lines/Boat	4.3	3.7	3.6	3.9
Boat Hours	971.3	812.0	871.6	2,654.9
Fished Hours	922.7	755.2	845.1	2,523.0
Avg. Boat Trip Length	10.3	7.5	7.7	8.2
Avg. Fishing Time	9.8	7.0	7.5	7.8
Fishermen Hours	3,195.6	2,809.5	3,172.6	9,174.1
Line Hours†	3,995.3	2,801.6	3,009.8	9,806.7
# Fish Landed	231.0	283.0	100.0	615.0
Catch Landed (Kg)††	2,106.7	2,201.0	1,341.8	5,649.5
Kg/Boat	24.78	21.79	14.74	45.93
Kg/Boat Trip	22.41	19.14	11.87	17.54
Kg/Boat Hour	2.17	2.71	1.54	2.13
Kg/Man Hour	0.66	0.78	0.42	0.62
Kg/Line Hour	0.53	0.79	0.46	0.58

*Daily total assumes no turnover of participants for boats with multiple trips per day; derby total is given as 100% turnover.

**Artificial data based on the average number of lines per boat interviewed, multiplied by the number of boats.

†Based on the actual time spent fishing and overall average number of lines per boat.

††Includes incidental catch of non-derby species.

Catch

The 4,316.6 kg of derby species landed was 31% less than the record 6,273.8 kg of derby species landed during the 1989 GIFD and the lowest in the last four years (Tables 2, 3). The vast bulk (79%) of the catch consisted of blue marlin (3,398.8 kg). Including the by-catch, which accounted for 33% of the fishes but only 24% of the weight, 623 fish weighing 5,646.8 kg were caught. This is also the lowest derby total in the last four years.

The mean catch per boat per trip was 17.5 kg less than 41% of the overall catch rate of the 1989 derby. Like the overall catch rate, the catch rates for each of the derby species except mahimahi were considerably lower than those of last year's derby (Table 3). The catch rate for blue marlin greatly exceeded those for all other species (1.34 vs 0.05 to 0.22 kg/boat-hour fished), but was only 39% of that of last year's derby.

Sixty-two blue marlin weighing 3,396.0 kg were landed during the 1990 GIFD. This was the lowest total since 1986. The mean weight of 53.5 kg was the smallest in derby history

and the 133.8 kg winning fish was smallest for all years except 1978 and 1982. In addition to blue marlin, one 29.9 kg sailfish was also caught.

Table 2. Daily catch composition for the fourteenth annual Guam International Fishing Derby (6-8 July). Weights are expressed in kilograms (1kg=2.2lbs).

	DAY 1			DAY 2			DAY 3			DERBY TOTALS		
SPECIES	Σ #	Σ Kg	Avg Kg	Σ #	Σ Kg	Avg Kg	Σ #	Σ Kg	Avg Kg	Σ #	Σ Kg	Avg Kg
Derby												
Blue Marlin	20	1,155.2	57.8	28	1,310.7	46.8	15	903.1	60.2	63	3,369.0	53.5
Sailfish							1	29.9	29.9	1	29.9	29.9
Yellowfin Tuna	42	340.4	8.1	25	131.9	5.3	14	74.1	5.3	81	546.3	6.7
Wahoo	10	77.9	7.8	6	43.1	7.2	18	128.7	7.2	34	249.7	7.3
Mahimahi	8	44.9	5.6	7	30.8	4.4	10	45.9	4.6	25	121.6	4.9
Non-Derby												
Skipjack Tuna	149	449.6	3.0	187	600.3	3.2	37	151.0	4.1	373	1,200.9	3.2
Kawakawa	3	7.7	2.4	11	25.0	2.3				14	32.7	2.3
Dogtooth Tuna	1	8.1	8.1							1	8.1	8.1
Rainbow Runner							1	1.9	1.9	1	1.9	1.9
Barracuda	7	22.9	3.3	19	59.2	3.1	4	7.3	1.9	30	89.4	3
TOTALS	240	2,106.7	8.8	283	2,201.0	7.8	100	1,341.8	13.4	623	5,649.5	9.1

The catch of 81 yellowfin tuna was the same as last year's, but the total weight (546.3 kg) and mean size (6.8 kg) were up slightly. It should be noted that the mean size was considerably smaller than for all but one of the years prior to 1984.

The catch of 34 wahoo weighing 249.7 kg was lower than that of most recent derbies. The winning wahoo of 17.6 kg was exceeded on all but two of the 14 derbies, but was still fairly close to the winning weight for three of the last five derbies.

The mahimahi catch of 25 fish weighing 121.6 kg was the second largest on record and somewhat atypical of the summer season. However the 10.8 kg winning fish was smaller than most of the derby winners.

At least five "non-derby" species were landed, accounting for the bulk of the individual fishes (67%) but only 24% (1,330.2 kg) of the overall derby catch. Nearly all of this consisted of skipjack tuna (1,200.9 kg) with the remainder consisting of 132.1 kg of barracuda, kawakawa, dogtooth tuna, and rainbow runner.

Fishing areas

Useable locality data was obtained from 58% of the returning boats. This made it possible to compare catches and catch rates by area (Table 4). However, the small number of trips to some areas makes certain comparisons highly subjective. Most of the fishing effort was spent north of Orote Point (all or part of 91% of the boat trips vs 14% south of Orote). Most of the catch was also from the north, as well as the overall best catch rates for blue marlin and yellowfin tuna. This year, fishing for marlin was better around Guam's and Rota's coastal waters than either the northern or southern banks. Fishing for yellowfin

Table 3. Catch comparison for all Guam International or Marianas Fishing Derbies 1. Weights are expressed in kilograms (1 kg=2.2 lbs).

	1977	1978	1979	1980	1981	1982	1983	19842	1985	1986	19873	1988	1989	1990
BLUE MARLIN														
no. caught	9	9	6	12	34	12	13	47	17	47	43	58	86	64
total weight	932.9	511.1	702.9	727.0	2,005.0	852.2	964.2	2,840.4	1,659.0	2,859.0	4,008.2	3,831.9	5,263.6	3,398.9
ave. weight	103.6	56.8	117.2	60.6	59.0	71.0	74.2	60.4	97.6	60.8	93.2	66.1	61.2	53.1
winning fish	191.8	75.3	237.2	138.8	145.1	132.0	199.1	215.4	177.8	173.7	188.2	155.3	182.2	133.8
YELLOWFIN TUNA														
no. caught	18	11	34	50	109	205	100	59	137	71	116	161	81	81
total weight	239.9	254.9	637.2	307.9	1,156.0	2,376.9	1,105.7	388.8	1,058.0	405.9	858.5	848.5	385.2	546.3
ave. weight	13.3	23.2	18.7	6.2	10.6	11.6	11.1	6.6	7.7	5.7	7.4	5.3	4.8	6.8
winning fish	46.3	56.7	67.6	51.2	47.6	61.2	55.8	51.7	45.8	45.8	26.8	44.9	21.5	39.9
WAHOO														
no. caught	7	9	11	12	33	60	36	46	98	16	31	72	59	34
total weight	90.7	102.0	116.1	161.0	542.9	263.9	359.6	466.2	921.5	136.5	314.3	567.4	588.1	249.7
ave. weight	13.0	11.4	10.5	13.4	16.5	4.4	10.0	10.1	9.4	8.5	10.1	7.8	10.0	7.3
winning fish	22.2	19.0	19.5	23.6	16.8	22.7	24.5	21.3	23.6	17.7	16.8	22.4	17.9	17.6
MAHIMAHI														
no. caught	2	4	5	3	1	14	33	0	14	7	3	5	7	25
total weight	13.6	26.3	52.6	39.5	0.9	63.5	195.0	0.0	76.6	61.7	39.9	12.2	36.9	121.6
ave. weight	6.8	6.6	10.5	13.1	0.8	4.6	5.9	0.0	5.5	8.8	13.4	2.4	5.3	4.9
winning fish	9.1	9.1	15.0	15.9	0.9	15.0	10.9	0.0	15.0	14.5	15.4	4.3	18.4	10.8
DERBY SPECIES														
no. caught	36	33	56	77	177	291	182	152	266	141	193	296	233	205
total weight	1,277.6	894.3	1,508.4	1,235.4	3,704.8	3,556.9	2,624.5	3,695.2	2,716.1	3,463.5	5,220.9	5,260.0	6,273.8	4,316.6
most per boat											57	42	26	
TOTAL CATCH														
no. caught							281	336	427	237	488	993	562	623
total weight	0.0	0.0	0.0	0.0	0.0	0.0	3,277.6	4,365.1	4,370.1	3,794.1	6,668.5	8,188.4	7,969.8	5,646.8

1Based on returned catch reports for 1977 to 1983, but includes estimated bicatch and unreported catches for 1984 to present. Only the principal derby species are reported for 1977 to 1982.

2Based on known catches of principle derby species and estimated catches of non-derby species expanded for non-reporting boats.

3Figures for blue marlin and yellowfin tuna originally reported are in error. The corrected figures are given here.

4Includes 2 sailfish weighing a total of 124.3 lbs in 1989 and 1 sailfish weighing 66.0 lbs in 1990.

5Includes all tuna species.

Table 4. Effort, catch, and catch rates by area for the fourteenth annual GIFD. Effort is based on the number of boat trips in which area fished was reported and includes all boats known to have fished within a given area. A small number of catches from unspecified areas are not included.

Area	Effort (number of boat trips)	Catch								Catch rate (no. and kg./trip)							
		Blue marlin		Yellowfin tuna		Wahoo		Mahimahi		Blue marlin		Yellowfin tuna		Wahoo		Mahimahi	
		no.	kg.	no.	kg.	no.	kg.	no.	kg.	no.	kg.	no.	kg.	no.	kg.	no.	kg.
North	170	53	3,189.8	55	395.7	21	191.2	18	79.7	0.31	18.8	0.32	2.3	0.12	1.1	0.11	0.5
NW Guam[1]	146	35	1,897.8	4	69.6	6	55.7	3	15.0	0.24	13.0	0.03	0.5	0.04	0.4	0.02	0.1
N. Banks	97	14	835.9	28	141.0	9	73.1	8	32.0	0.14	8.6	0.29	1.5	0.09	0.8	0.08	0.3
NE Guam[2]	6	-	-	3	13.6	1	13.6	2	9.9	-	-	0.50	2.3	0.17	2.3	0.33	1.7
Rota	4	2	267.9	15	95.5	5	48.8	5	22.8	0.22	29.8	1.67	10.6	0.56	5.4	0.56	2.5
South	26	5	309.0	4	49.3	8	53.3	3	9.9	0.19	11.9	0.15	1.9	0.31	2.1	0.12	0.4
SW Guam[3]	7	3	166.2	1	5.6	-	-	1	2.4	0.43	23.7	0.14	0.8	-	-	0.14	0.3
S. Banks	14	2	142.9	3	43.7	8	53.3	1	7.5	0.14	10.2	0.21	3.1	0.57	3.8	0.07	0.5
Total	186	58	3,498.8	59	445.0	29	244.5	21	89.6	0.31	18.8	0.32	2.4	0.16	1.3	0.11	0.5

[1]Orote Pt. to Ritidian Pt.

[2]Tarague to Pati Pt.

[3]Orote Pt. to Cocos.

tuna was better around the offshore banks, northeast Guam, and Rota than the western coastal areas of Guam. Rota and the southern banks produced the best catches of wahoo, and Rota and northeast Guam produced the best catches of mahimahi. Catch rates for nearly all species and areas were well below those of last year and the pattern of highest effort and highest catches in the north, but highest catch rates in the south of last four GIFDs did not hold this year.

ACKNOWLEDGEMENTS

The fisheries biologists from DAWR wish to thank the competing anglers, the Guam Visitor's Bureau, members of the fourteenth GIFD derby committee, and the Guam Fishermen's Cooperative for their cooperation and assistance in providing the catch information that made this report possible. This cooperation not only makes our job easier and more enjoyable, but insures a more accurate collection of data and better information for the fisherman.

Report prepared by: Robert F. Myers

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Inshore Fisheries Survey

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

Monthly inshore fisheries surveys were conducted along Guam's shoreline from October 1989 to September 1990. The total estimated inshore fisheries catch for this time period was 54.1 mt, 97.5% of which were finfish. Hook and line was the most popular method accounting for 68.7% of the total participation* or 32,316 participants. Drag net fishing was the most successful method (both night and combined) in terms of catch rate, yielding approximately 6.80 kg/gear-hour and a harvest of 1.1 m.t. Surround net fishing was the most successful daytime method in terms of catch, yielding approximately 4.00 kg/gear-hour and a harvest of 0.6 mt. The seasonal fisheries (scads and manahac) accounted for 21.0% of the total finfish harvest or 11,059 kg.

BACKGROUND

Effective management of Guam's inshore fishery resources requires accumulating data on the types of fishing methods used, fishing pressure, and annual catch. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatic and Wildlife Resources (DAWR) has been monitoring marine fishing activities since the early 1960's. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. In the last several years, however, field survey techniques have been expanded and refined, while estimates of Guam's recreational/subsistence fishing activities have come to be based on more reliable data analysis techniques.

OBJECTIVES

1. To estimate the total annual inshore participation, effort and harvest of Guam's inshore recreational/subsistence fisheries through statistically valid surveys and analysis.

2. To gather limited biological data that will add to a long-term historical database on Guam's important inshore fish species.

PROCEDURES

During FY90, day and night "inshore participation" surveys were conducted on four randomly selected days per month. These surveys entailed making visual observations of

* All participation and effort statistics except total harvest exclude seasonal fisheries data.

not only participation among the various fishing methods employed, but also of the reef zones and general locations that were fished within the more readily accessible portions of Guam's coastline (Figure 1, locations 1-71). Based on data collected during nine non-consecutive years of aerial surveys conducted between FY63 and FY79, approximately 85% of Guam's inshore fishing activities is known to occur within this area. The starting location for each survey was selected at random and the "circular" direction of driving was alternated between surveys. This was modified slightly due to road construction and closure between Agat to Umatac, beginning January 1990. The route, until reopening of the road, was to alternate days between Agat (starting at Agat driving clockwise to Umatac) and Umatac (starting at Umatac and driving counterclockwise to Agat). Observations were made while driving the route once without backtracking. These methods were applied for both day and night participation surveys.

In addition, four "inshore-catch" survey days were selected. During these catch days, a fisherman-intercept survey was conducted to gather catch, effort, and species composition data for both day and night fishing. The day survey covered a six-hour interval (starting at 0630 hours) and the night survey covered a five-hour interval (starting at 1900 hours). Only one of three survey regions (Fig. 1) was selected for each "inshore-catch" day and fisheries data collection was restricted to that region. However, because of infrequently used methods (i.e., drag net and surround net), representative samples were sometimes difficult to obtain. Therefore, if a particular fishing method was not observed within the selected survey area during a survey, one of the other two areas could be searched.

Seasonal data (tiao' and e'e') was acquired through actual participation and catch surveys. Because of the lack of information during these surveys on other seasonal fish (fusiliers, scads and manahac), catch information was obtained through incidental interviews with fishermen, conversations with village mayors, DAWR Conservation Officers and other biologists.

Because the coastal fishing participation and range has steadily increased over recent years, aerial surveys were reinstated around Guam during FY90 in order to update island-wide participation estimates. Aerial surveys were begun in October 1989 and conducted twice monthly. The surveys were performed on regularly scheduled participation days (one weekend and one weekday) and began on the hour, rotating through from 0800 to 1200 for each subsequent survey. Visual observations of the fishing methods, participants, gear units and areas fished were recorded as done in the inshore participation survey. Other data collected during these flights include observations of marine mammals and turtles, offshore fishing activity, FAD (fish aggregation device) use and other incidental information.

The FY90 inshore harvest estimates were calculated by a computer software package known as the Guam Inshore Expansion System (GIES). The GIES utilizes formulae described in the FY85 project report (Project No. FW-2R-22, Sub-Project F, Study No. F-1, Job No. 2).

RESULTS

During FY90, the estimated inshore harvest for day, night, and seasonal fishing around Guam was 54.1 mt. Finfish accounted for 97.5% of the total harvest, or 52.7 mt. Aside from these two initial statements, for the purposes of comparison to past reports when catch or effort statistics of the inshore fishery are reported, the seasonal harvest (scads, manahac and fusiliers) has been deleted due to insufficient effort data to properly assess these sporadic fisheries. The total fish catch (finfish and non-finfish) resulted from a total effort of 214,405 person-hours and 199,991.8 gear-hours. Overall, approximately 0.27 kg of fish were taken per gear-hour. Estimated participation, effort, and catch values for

each fishing method are shown in Table 1-3. The values in Table 1 are combined estimates of separate expansions of day, night, and seasonal catch data collections. Tables 2 and 3 present the participation, effort, and catch for day and night fishing for each method.

Figure 1. Inshore Fisheries "Participation Survey" Route with Area and Location Codes.

A decrease in total harvest was seen in FY90 (54.1 mt) compared to FY89 (127.5 mt). The number of participants and gear-hours increased slightly from FY89 to FY90, but are probably not significantly different due to the large coefficient of variation observed in some of the methods. The drop in total expanded catch in FY90, is mostly attributed to a poor harvest for the seasonal fisheries, but should be analyzed with previous survey data to ensure this is the only reason for the decline in total harvest.

Effort

Hook and line fishing was, by far, the most popular method based on the total participation (combined day and night values), accounting for 32,316 persons or approximately 68.7% of the total participation. Cast netting was the second most popular method overall accounting for 6,473 participants or 13.8% of the total participation, while gill netting followed with 5,555 participants or 11.8% of the total.

The rank order for day fishing participation placed hook and line first with more than 3.7 times as many participants as any other method, 23,637 (68.9%) participants. Cast net and gill net placed second and third respectively with 6,403 (18.7%) and 3,615 (10.5%) participants.

Hook and line remained the most popular night fishing method with 8,679 participants and 68.3% of night participation. The second most popular method was gill net fishing with 1,940 participants or 15.3% of night fishing, while spearfishing with snorkel gear followed with 1,586 participants or 12.5% of night fishing

Catch

Hook and line fishing yielded the largest harvest overall of 14.8 mt or 35.3% of the total harvest. Gill net fishing followed with 12.0 mt or 28.7% of the total harvest and cast net fishing was third with 10.1 mt or 24.1% of the overall total.

Due to more than 70% of the total harvest resulting from day fishing, the rank order for day harvest varied only slightly from that of the combined harvest with the percent harvest falling near 30% for the top three methods. Hook and line fishing yielded the largest harvest overall of 11.4 mt or 36.7% of the day harvest. Cast net fishing followed with 10.1. mt or 32.3% and gill net fishing was third with 8.6 mt or 27.7 % of the day harvest.

Hook and line and gill net fishing both had the highest night harvest with 3.4 mt of the total night harvest or 31.6% and 31.5%, respectively. Hook and line ranked slightly higher in actual numbers than gill net fishing but was probably not significantly different. Spearfishing with snorkel gear followed with 2.3 mt or 21.6% of the total night fishing.

Catch Per Unit Effort (CPUE)

Surround net fishing had the highest daytime catch per unit effort (CPUE) of 4.0 kg/gear-hour for day fishing. Gill net fishing followed with 1.17 kg/gear-hour and "other methods" was third with 0.62 kg/gear-hour.

Drag net fishing had the highest nighttime CPUE of 6.8 kg/gear-hour for night fishing. Spearfishing with scuba followed with 2.29 kg/gear-hour and gill net fishing was third with 1.21 kg/gear-hour.

The information concerning effort and harvest for methods not discussed are included in the summary Tables 1-3.

Other nearshore fisheries harvests, including spearfishing, are recorded on Guam and those results appear in the Offshore Fisheries Report (Project No. FW-2R-26, Sub-Project F-1, Study No. 1, Job No. 1), due to harvest by boat.

The species composition for the FY90 expanded harvest for day, night, and combined are presented in Tables 4, 5, and 6. The top day caught species was *Selar crumenophthalmus*, one of several seasonal fish caught in FY90. The top night-caught species was *Mulloides flavolineatus,*, which was taken primarily by gill net and drag net fishing. The family Scaridae or any species in this family failed to rank among the top ten families or species caught at night. The scarids did rank 14th and 15th for the day and night, respectively. This ranking is similar to that reported in the FY87 annual report. The scarids are typically a major contributor to the night harvests and this absence from the top 10 families cannot be attributed to over-fishing at this time but requires further investigation by comparing past years' database. In general the top ten families remained the same as those in FY89 with

some shifts in rank order, but the harvest estimates for species and families in all categories dropped considerably. *Lutjanus bohar* appeared in the top ten ranking for the first time. This will be investigated with past database to determine if this placement is due to lower overall catches or to sampling technique. *Caranx melampygus* placed eleventh in the night rankings. Even though this fish is not normally caught at night, part of this catch can be explained by the large number of *C. melampygus* (e'e') caught at or around sunset (by hook and line and cast net fishing) and were included in the night surveys.

Some of the major shifts in rank order of harvest value for species and family groups may have resulted from the shift in importance of method participation. The shift in importance between fishing methods toward hook and line, may be a function of the data collection technique but requires assessment. Some of the other shifts suggest that fisheries effort may be shifting toward harvest methods with higher catch rates. Past years' data needs to be analyzed and compared and if a shift to higher catch rates is proven to be valid information, this could require management to prevent overfishing.

The seasonal catch of certain juvenile fishes is widely anticipated by local fishermen. The catches of tiao' and e'e' are usually well represented within the expansion estimates (Tables 1-3). During FY90, pulses of recruiting juvenile jacks (e'e') occurred from June through September while few juvenile goatfish (tiao) were observed caught.

Three specific seasonal fisheries require special mention, *Selar crumenophthalmus*, *Siganus spinus* and *Pteroceasio tile*. FY90 marked an unexceptional year for scads (*Selar crumenophthalmus*). Even though the season (September through December) was unexceptional, *S. crumenopthalmus* represented the largest combined and day caught species with 10,886.4 kg. During FY90 the manahac (juvenile rabbitfish) did not run in large numbers. In fact, FY90 had a smaller run (172.7 kg) than FY89 (1,500 kg). The last large run of manahac was seen in FY88. *Pteroceasio tile*, often mistaken for baby rainbow runner (*Elagatis bipinnulatus*), did not run, but this fish does not recruit en masse every year. The last year this fish appeared in any large quantities was in 1984. The harvest estimates for these fisheries were determined independently from the GIES system due to the sporadic nature of these fisheries.

In addition to finfish, a number of other organisms were taken from the reefs throughout the year. The estimated harvest of octopus amounted to a 982.8 kg and was caught at the rate of 0.42 kg/gear-hour. Beyond this, the "other methods", such as gleaning, produced an estimated 0.4 mt of various crustaceans, gastropods, and bivalves with a catch rate of 0.89 kg/person-hour of fishing effort. Adding the non-finfish harvest brings the total island inshore harvest to 54,104.8 kg.

RECOMMENDATION

The initiation of computer stored records in FY82 and the development of the GIES program in FY85 has greatly reduced the amount of time needed to compile and analyze Guam's inshore fisheries survey data. Because of this, more effort has been spent to continually upgrade our data collection procedures to ensure statistical reliability.

Initial aerial observations show that 87.2% of the participants and 87.3% of the gear-units are being surveyed on the inshore participation route when compared to the island-wide count. Even though this falls within the estimated 85% from previous aerial surveys (FY 63-79), it is recommended that the aerial surveys be continued. The sampling technique has improved since the initiation of the aerial surveys and with further data, better quantitative analysis can be done for island-wide inshore fishing effort. Comparisons with aerial participation data could then be statistically compared to data obtained during the

regular inshore participation in order to upgrade the inshore survey techniques, if necessary.

Since the inshore fisheries survey provides information important for management and planning, it is recommended that this job be continued. During FY90, the GIES computerized expansion system was evaluated and rewritten. The new expansion and an upgrade in hardware to a Macintosh computer system will greatly enhance the analytical capabilities during FY91. Once all these changes have been accomplished, an effort to systematically analyze previously collected inshore data is needed in order to establish management needs, if indicated. With these analyses, reasons for the shift in fishing effort, ranking of fish species (i.e., absence of scarids, presence of snappers) and overall decline in total catch, other than data collection techniques, should be made clear. Other changes in fishing methods (gill net, spearfishing) should be analyzed with respect to offshore fishing to determine if any differences are due to increases in boat use for these methods, especially in the southern portion of Guam.

Report prepared by: Rebecca A. Hensley and Timothy S. Sherwood

Table 1. Combined estimated annual (FY90) inshore fishing participation, effort and harvest for day and night for all methods.

Method (TOTAL)	No. Persons	No. Gear Units	No. Trips	Person-Hours	Gear-Hours	Catch (Kg)	CPUE
Hook and Line	32,316.10	33,558.90	19,052.95	100,196.60	104,577.90	14,794.00	0.14
Cast Net	6,473.50	5,953.70	5,631.60	82,890.90	76,476.10	10,096.10	0.13
Gill Net	5,555.40	2,555.80	2,402.90	21,967.90	10,175.00	12,004.10	1.18
Surround Net	252.10	45.80	45.80	756.30	137.50	550.00	4.00
Spearfishing (SN)	1,987.20	1,978.50	924.90	5,452.30	5,419.30	2,788.80	0.51
Spearfishing (SC)	175.10	175.10	81.00	273.70	273.70	560.30	2.05
Drag net	280.50	65.90	65.90	854.60	156.80	1,065.50	6.80
Seasonal Total	N/A	N/A	N/A	N/A	N/A	11,059.1	N/A
Finfish totals	47,039.90	44,333.70	28,205.05	212,392.30	197,216.30	52,745.2	
Octopus	701.60	1,035.60	540.60	1,590.40	2,353.10	982.80	0.42
"Other"	223.20	223.20	215.00	422.40	422.40	376.80	0.89
All catch Totals	47,964.70	45,592.50	28,960.65	214,405.10	199,991.80	54,104.8	

Table 2. Estimated annual (FY90) inshore fishing participation, effort and harvest for the daytime period for all fishing methods.

Method (DAY)	No. Persons	No. Gear Units	No. Trips	Person-Hours	Gear-Hours	Catch (Kg)	CPUE
Hook and Line	23,637.40	24,978.30	14,497.40	77,905.30	82,467.50	11,409.70	0.14
Cast Net	6,403.00	5,896.10	5,574.00	82,842.90	76,436.50	10,052.20	0.13
Gill Net	3,615.70	1,755.90	1,626.20	15,172.10	7,373.60	8,627.80	1.17
Surround Net	252.10	45.80	45.80	756.30	137.50	550.00	4.00
Spearfishing (SN)	400.80	400.80	153.50	1,128.00	1,128.00	473.60	0.42
Spearfishing (SC)	24.70	24.70	24.70	37.10	37.10	18.50	0.00
Manahac						172.7	
Fusilier						0.0	
Scads						10,886.4	
Finfish Totals	34,333.70	33,101.60	21,921.60	177,841.70	167,580.20	42,190.9	
Octopus	596.80	930.80	435.80	1,485.60	2,248.30	878.00	0.39
"Other"	58.50	58.50	50.30	257.70	257.70	159.10	0.62
Day Total	34,989.00	34,090.90	22,407.70	179,585.00	170,086.20	43,228.0	

Table 3. Estimated annual (FY90) inshore fishing participation, effort and harvest for nighttime period for all fishing methods.

METHOD (NIGHT)	No. Persons	No. Gear Units	No. Trips	Person-Hours	Gear-Hours	Catch (Kg)	CPUE
Hook and Line	8,678.70	8,580.60	4,555.55	22,291.30	22,110.40	3,384.30	0.15
Cast Net	70.50	57.60	57.60	48.00	39.60	43.90	1.11
Gill Net	1,939.70	799.90	776.70	6,795.80	2,801.40	3,376.30	1.21
Spearfishing (SN)	1,586.40	1,577.70	771.40	4,324.30	4,291.30	2,315.20	0.54
Spearfishing (SC)	150.40	150.40	56.30	236.60	236.60	541.80	2.2
Drag Net	280.50	65.90	65.90	854.60	156.80	1,065.50	6.8
Finfish Totals	12,706.20	11,232.10	6,283.45	34,550.60	29,636.10	10,727.00	
Octopus	104.80	104.80	104.80	104.80	104.80	104.80	1.00
"Other"	164.70	164.70	164.70	164.70	164.70	1217.70	1.32
Night Totals	12,975.70	11,501.60	6,552.95	34,820.10	29,905.60	11,049.50	

Table 4. FY90 day catch composition for the top ten species and families harvested.

Species	Harvest (Kg)	%	Family	Harvest (Kg)	%
Selar crumenopthalmus	10,886.4	25.80	Scads*	10,886.4	25.80
Mulloides flavolineatus	3,250.4	7.70	Acanthuridae	5,508.2	13.06
Acanthurus triostegus	2,954.5	7.00	Carangidae	3,820.0	9.05
*Siganus spinus***	2,924.9	6.93	Mullidae	3,685.1	8.73
Caranx melampygus	2,654.1	6.29	Siganidae	3,249.7	7.70
Gerrus argyreus	2,402.9	5.70	Muglidae	2,430.0	5.76
Kyphosus cinerascens	2,071.6	4.91	Kyphosidae	2,076.8	4.92
Naso unicornis	1,843.3	4.37	Lutjanidae	1,437.9	3.41
Lutjanus bohar	1,050.3	2.49	Lethrinidae	1,087.0	2.58
Liza vaigiensis	986.7	2.34	Hemirhamphidae	958.0	2.27
Total day finfish	42,190.0	73.53	Total	42,190.9	83.28

*The scads were separated from the family Carangidae due to differences in harvest method and management significance.
** Manahac (*Siganus spinus* and/or *S. argenteus*) not incorporated into species ranking, but included in family ranking

Table 5. FY90 night catch composition for the top species and families harvested.

Species	Harvest (Kg)	%	Family	Harvest (Kg)	%
Mulloides flavolineatus	1,295.4	12.08	Mullidae	1,507.3	14.05
Gerrus argyreus	607.6	5.66	Acanthuridae	1,242.9	11.59
Lethrinus harak	562.4	5.24	Lethrinidae	1,201.1	11.20
Acanthurus triostegus	391.0	3.64	Lutjanidae	825.8	7.70
Aprion virescens	360.2	3.36	Carangidae	611.6	5.70
Diodon hystrix	359.6	3.35	Gerridae	607.6	5.66
Siganus spinus	344.6	3.21	Muglidae	551.6	5.14
Crenimugil crenilabis	321.0	2.99	Siganidae	513.2	4.78
Naso unicornis	313.7	2.92	Holocentridae	476.6	4.44
Lethrinus elongatus	300.1	2.80	Muraenidae	390.0	3.64
Total night finfish	10,727.0	45.52	Total	10,727.0	73.90

Table 6. FY90 combined catch composition for the top species and families harvested.

Species	Harvest (Kg)	%	Family	Harvest (Kg)	%
Selar Crumenopthalmus	10,886.4	20.57	Scads*	10,886.4	20.57
Mulloides flavolineatus	4,545.8	8.59	Acanthuridae	6,751.7	12.76
Acanthurus triostegus	3,345.5	6.32	Mullidae	5,192.4	9.81
*Siganus spinus***	3,269.5	6.18	Carangidae	4,431.5	8.37
Gerrus argyreus	3,010.5	5.69	Siganidae	3,762.2	7.11
Caranx melampygus	2,983.4	5.64	Muglidae	2,981.6	5.63
Naso unicornis	2,157.0	4.08	Lethrinidae	2,288.1	4.32
Kyphosus cinerascens	2,071.6	3.91	Lutjanidae	2,263.7	4.28
Lutjanus bohar	1,286.2	2.43	Kyphosidae	2,076.8	3.92
Lethrinus harak	1,254.3	2.37	Serranidae	1,042.2	1.97
Total all finfish	52,917.9	65.78	Total	52,917.9	78.74

* The scads were separated from the family Carangidae due to differences in harvest method and management significance.
** Manahac (*Siganus spinus* and/or *S. argenteus*) not incorporated into species ranking, but included in family ranking

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 13

JOB TITLE: Remote Sensing with Satellite Imagery

PERIOD COVERED: October 1, 1989 to September 30, 1990.

SUMMARY

The use of satellite imagery in fisheries management is relatively new. With the current satellites in orbit, it is possible to use this technology as a data source for the monitoring of environmental conditions that affect fish migrations. DAWR is currently studying the feasibility of using satellite imagery to predict fish migrations and aid in the development of fishery management plans.

BACKGROUND

Many of the popular inshore and offshore fisheries of Guam are seasonal. A good example of this is the rabbitfish, *Siganus spinus*. After spawning, the larval fish spend 60 to 90 days at sea before recruiting back on to Guam's reefs in mass during the fourth, fifth, and tenth last quarter lunar phases. Although the moon and tides influence the time of these migrations, it appears that other environmental factors affect the size. The prediction of time and size of migrations would be of great benefit for the management of these fish and reduce possible user conflict. Amesbury et al (in press) has shown that there is a shift in the sea surface temperature shift from the rainy season to the dry season of 3° C. It is felt that by monitoring the sea surface temperatures with satellite imagery, DAWR may be able to predict the size and time of seasonal fish migrations.

OBJECTIVES

1) Conduct literature search on the techniques currently being used for remote sensing for coral reef areas the use for prediction of fish migrations.

2) Determine if these techniques are applicable to Guam's region.

RESULTS

There are currently 3 satellites that are commonly used as remote sensing platforms to monitor environmental processes. These satellites are the NOAA polar orbiters, SPOT and the LANDSAT platforms.

1) NOAA currently has NOAA-10 and 11 polar orbiters working with a resolution of 1 km. The orbits of these satellites are such that they pass over the same point twice a day. This satellite was designed for the observation of weather systems. This data is broadcasted at all times and is available to anyone who has the equipment to receive the signal. The advantage of this satellite for environmental studies is that it is able to image a large area during the daylight and nighttime hours. This gives the user the ability to create real time maps of sea surface temperature, vegetation index, and current. By using the

sensors in the visual range, it may also be possible to monitor large fishing vessels at night by using the lights on the boat. This system is currently being used by the Japanese government to predict migrations and spawning activity of fish (Yamanaka et. al, 1988).

2) LANDSAT is used for mapping large land areas and has a resolution of up to 30 meters. This satellite passes over the same point once every 16 days and will cover an area of 185 km by 185 km. The images acquired by this satellite are becoming expensive to obtain. LANDSAT images can be used for such things as geological formations and sedimentation, but the sensors are not set up for small coastal areas. This data has been used for land use planning and vegetation cover in South East Asia, (Brainbridge, 1988).

3) SPOT is a satellite that is put up by the French. This satellite has the capability of acquiring an image of the same area every 1 to 5 days. The resolution of this data is at 10 meters and one scene will cover an area of 60km by 60km. The SPOT satellite has the unique ability to take stereo-images of the target area. This imagery is also expensive (about $1500 per scene) but the possible uses of this data are unlimited. This imagery has been used to create accurate bathymetery maps of the Tetembia Reef, New Caledonia (Kuchler et al, 1988). The use for fisheries management for imagery is enormous. It is possible to use this imagery to produce a map of the reef habitat. Then by composing a list of important marine species and the habitats they exist in, with the use of a computer, it would be possible to estimate the maximum carrying capacity of the reef.

The integration of data from these three sources would be of great advantage. The NOAA satellites can give rough real time data, for such things as sea surface temperature and current direction, while the SPOT data would be able to monitor sedimentation on reefs and the reef habitat. Although the sensors cannot "see" through clouds, cloud-free scenes of LANDSAT and SPOT would only be required twice a year. The NOAA data would suffer from the same problem, but with two images acquired during the daylight hours it would be possible to "cut and paste" between images and create one image with total coverage.

RECOMMENDATION

The Division of Aquatic and Wildlife Resources should continue to investigate the use of satellite imagery with respect to fisheries management. An analysis of computer systems capable of manipulating satellite images should be conducted. These systems need to have the ability to acquire the NOAA broadcasts and manipulate LANDSAT and SPOT images. The local or timely servicing of equipment and training on software packages must be emphasized before selecting a system.

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Report prepared by: Timothy S. Sherwood

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: F-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Fisheries Data Processing

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

During FY90, offshore and inshore fisheries survey data were entered onto computer files and edited for completeness and accuracy. The offshore database for this fiscal year contains 4,321 records and the "inshore-participation" and "inshore-catch" databases contain 48 and 436 records, respectively. The primary software packages used for data analysis were the Guam Offshore Expansion System (GOES) for the offshore fisheries survey data and the Guam Inshore Expansion System (GIES) for the inshore fisheries survey data.* No new data was entered into the database for Job 8, "Studies of Recreationally Important Reef Fish".

BACKGROUND

Guam's Division of Aquatic and Wildlife Resources (DAWR) has been collecting fisheries information over the past 22 years (with only the last thirteen years of data being reliable) and, as a result, an enormous amount of fisheries management data has been accumulated. Computers have been used over the past six years by DAWR to store and analyze this data. DAWR personnel, working closely with the National Marine Fisheries Service (NMFS), have developed and purchased programs for analyzing the Division's offshore and inshore fisheries survey data.

In FY83, a program entitled the GOES was developed based on the current practices of offshore data analysis and, in FY85, the GIES was completed and tested for errors (this program underwent modifications in FY90 to take advantage of the storage capability and speed of computers that are currently available). Since this time, all data collected for the offshore and inshore fisheries surveys have been analyzed through the use of these two programs.

Job 3, Fisheries Data Processing, has been jointly funded by the U.S. Fish and Wildlife Service, the NMFS, and the Western Pacific Regional Fisheries Management Council.

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*The "Guam Tournament" module for the GOES was not used in FY '90 due to a change in the keeping of the boat record logs after the module was developed. Derby totals for FY '90 are estimates based on expanded data. Details are given in the Annual Report for the Guam International Fishing Derby (GIFD).

OBJECTIVES

1. Computerize the DAWR's offshore and inshore marine fisheries data and transfer the finalized fisheries data files and reports to NMFS personnel in Honolulu, Hawaii for regional application.

2. Provide technical assistance to DAWR staff biologists in the form of efficient statistical analysis and report generation.

PROCEDURES

Guam's offshore fisheries survey data are analyzed by a system of computer programs known as the GOES. This programming package is a 5-step system that summarizes, sorts, and statistically expands the survey data to produce monthly and annual catch, effort, and species composition estimates. Two proportionality constants and a "total participation boat count" are calculated and manually entered into the expansion module by the user. Reports are generated by the GOES that give a breakdown of the estimated offshore harvest by gear type on a monthly and annual basis. Also, an estimated harvest by species is generated for each gear type with a corresponding percentage of the total catch for that gear type.

Guam's inshore fisheries survey data are analyzed by a programming package known as the GIES. The original GIES was a 4-step system that relies on two sets of survey data to determine an annual inshore estimated harvest. This program was modified this fiscal year so that the program can take advantage of the new computer technology in data storage and processing speed. The two sets of data are referred to as "inshore-participation" and "inshore-catch." "Inshore-participation" data consists of fishermen and gear counts obtained by biological aides when driving around the island and making observations on fishing activity within the fringing reef. "Inshore-catch" data are obtained by fishermen-intercept interviews that usually occur within a predetermined survey region. These data consist of a total catch and catch by species for each interview. Because of the apparent differences in participation and catch-per-unit-effort (CPUE) of the various gear types between daytime and nighttime fishing, a fisheries survey is conducted during each of these two time periods and the data are analyzed separately. Also, data are collected during the seasonal harvest of juvenile rabbitfish (*Siganus argenteus* and *S. spinus*) and bigeye scad (*Selar crumenophthalmus*) and analyzed separately from the creel data, due to differences between the seasonal and non-seasonal harvests.

RESULTS

Offshore Fisheries Survey Data Base Management

The DAWR's offshore fisheries survey data for FY90 were entered onto computer files and edited for completeness and accuracy. The total number of records for the FY90 offshore database is 4,321. This brings the total number of historical and current offshore records to 28,492. Since the FY90 GIFD data has not been entered onto the database, the total number of fishing derby records remains at 1,986.

Based upon the expansion calculated by the GOES, the estimated island-wide offshore harvest for FY89, including the GIFD results, is about 300 metric tons. For more detailed information, see Job 1, "Offshore Fisheries Survey."

Inshore Fisheries Survey Data Base Management

The FY90 DAWR inshore fisheries survey data were entered onto two databases. The number of records of the previous years' "inshore-catch" was the number of individual fish measurements, due to the modifications of the database, the number of records now refers to the number of interviews that are conducted and input. The previous years' "inshore-participation" referred to each activity in each area; with the new modifications, it is the number of days the participation surveys were conducted on. The "inshore-catch" and the "inshore-participation" databases for this fiscal year contain 436 and 48 records, respectively. This brings the total number of historical and current "inshore-catch" records to 3910 and the "inshore-participation" records to 504.

Based upon the expansion calculated by the GIES, the total FY90 harvest estimate for Guam's inshore fisheries, combining day fishing, night fishing, and seasonal fishing, is approximately 54.1 metric tons. For more detailed information, see Job 2, "Inshore Fisheries Survey".

Other Fisheries Data Bases

During FY87, a database was established for the storage and dissemination reef fish data used for Job 8, "Studies of Recreationally Important Reef Fish." No new records were entered as analysis has not been completed on the historical records. The total number of records contained in this data base remains at 1,687.

RECOMMENDATION

Data processing has become a valuable asset to the many research projects currently undertaken at DAWR. Data storage and retrieval, data analysis, and report generation has improved greatly since the installation of a computer system. The modifications to the inshore programs have greatly reduced the time required to input and process. It is, therefore, recommended that this office modify the GOES program to run on the new computers that are currently available.

Report prepared by: Timothy S. Sherwood

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: F-1
STUDY NO.: 3
JOB NO.: 1

JOB TITLE: Management of Guam's Marine Resources

STUDY 3: Studies of Guam's Recreationally-Important Fish (*Siganus spinus*)

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

During FY90, data collection and analysis were continued on the study of the rabbitfish, *Siganus spinus*, in the completion of a final report. Sufficient numbers of female fish, carrying ripe eggs, were collected to complete this project. Both annual and pre-spawning population distributions were plotted and used with fecundity data to derive the spawning capacity of the population. General knowledge of the fishing strategies, population dynamics and life histories were then utilized to develop proposed management plans. This plan will be implemented when it has been determined there is a need for management.

The studies on a goatfish (*Mulloides flavolineatus)* and an emperor snapper (*Lethrinus harak*) were tabled until FY91 at which time completion of data collections/analyses will be performed and continued through FY91 toward the completion of the final reports.

BACKGROUND

Rabbitfish (Siganidae) are common shallow water inshore reef fishes in the tropical Indo-Pacific. They are browsers of benthic algae. Most are schooling species which graze in seagrass beds, sand flats, reef flats and on shallow reef slopes. Juveniles and adults are highly prized as a food fish. Siganids are gonochoristic (separate, genetically determined sex which does not change over the lifetime of an individual). There are few external morphological differences between sexes. Thresher (1984) suggests that in all siganid species, females are larger than males at maturity. During the breeding season however, there is a conspicuous difference between sexes. Females with egg-swollen bellies are slower moving than males and have an enlarged genital pore (Duray and Duenas, unpublished; Lam, 1974).

Spawning and reproductive behaviors reported for siganids are similar to generalized descriptions for many reef fishes (Thresher, 1984; Munro, 1983). Peaks in spawning activity occur several times annually, spring and early summer and possibly late summer and early fall. Spawning seasonality is typical of siganids in general, with the exception of *Siganus guttatus,* which spawns all year round (Duray and Duenas, unpublished; Gundermann, 1983; Lam, 1974). Rabbitfish spawn in aggregations and have lunar spawning rhythms (Johannes, 1981), although the moon phase during which spawning actually takes place varies with each species. Lunar spawning activity has been reported to occur on or about (within 3-5 days before or after) the new, first quarter and full moon phases (Hara et. al., 1986). The actual timing of spawning varies with species. Lam (1974) suggests the times of spawning are cued by some extrinsic environmental factor,

possibly triggered by the falling tide. No repetitive spawning of females has been observed with the exception of a single female, *S. canaliculatus,* which was artificially induced to spawn during two consecutive months and was ripe again 1.5 months later (Bryan et al., 1975).

The eggs are demersal or neutrally buoyant and the larvae are pelagic. While in the planktonic stage, larvae feed on phytoplankton and zooplankton. The larval stage is reported to last from 23 to 30 days or longer (Gundermann, et. al., 1983). Juveniles of some rabbitfish species recruit to the reef in schools (Johannes, 1981; Kami and Ikehara, 1976). They do not feed for several days while their digestive tracts lengthen and become more complex to accommodate a shift in diet from plankton to algae.

Sexual maturity is reached in less than a year but at different sizes for various species. Lam (1974) reports that *S. canaliculatus* juveniles appear during the spawning season, which peaks in March and April. The fish reach adult size by December and are fully mature in late January or February, capable of spawning in March or April. It is not known whether siganids spawn in consecutive seasons. Lam (1974) reported that after spawning, spent *S. canaliculatus* disappear from the reef. However, Bryan et al. (1975) states for the same species that females which, spawned in captivity do not die when spent. Further, Lam (1974) reported that on occasion, exceptionally large (>180 g) *S. canaliculatus* are collected. These may be more than a year old. On Guam, wild caught juveniles of *S. argenteus* and *S. spinus,* hatchery raised, reach maturity and spawn within one year (Dr. S. Nelson, University of Guam Marine Lab aquaculture research center, personal communication).

Eight species of rabbitfish are reported from Guam (Kami et. al., 1968). *S. spinus* and *S. argenteus* are the most common. The fishery for adult siganids yields approximately 7% of the total harvest of finfish from the inshore reefs around Guam. Rabbitfish rank annually among the top 10 most frequently harvested species of reef fish on Guam. The total catch of siganids (exclusive of juvenile harvest figures) in the past has oscillated from year to year. Recent harvests have approximated 3,663 kg in FY86, 4,974 kg in FY87, 6,105 kg in FY88, 4,878 kg in FY89, and 3,663 kg in FY90 (DAWR Annual Reports, Job 2). Adult rabbitfish are primarily taken by hook and line, gill nets, surround nets, cast nets and spears.

Several times a year (March, April, May, possibly June and October, November), adult fish aggregate on reef flats, grassbeds and channels to spawn. The slow-moving, egg-laden females are particularly vulnerable to being caught at this time. Many species of reef fish, including rabbitfish, are unusually docile and approachable at this time. Natives of Palau refer to these fish as being "stupid" (Johannes, 1981). As a result of this behavior, paired with known convergence points and times, spawning fish afford large harvests.

In Palau, overfishing of juveniles during recruitment runs has led to reduced runs. Intense fishing for spawning adults with small mesh gillnets has led to a decline in size and numbers of adult fish (Johannes, 1981).

Juvenile rabbitfish settle out of the plankton onto the reef flats at predictable times of the year, on the 4th, 5th, and 10th lunar cycles. A lunar cycle consists of the new, first quarter, full and last quarter moon phases. Lunar cycles are counted in succession from the first new moon phase in January. This phase may not occur at the beginning of the month therefore, lunar cycles can overlap between months. Juvenile rabbitfish runs may occur in April, May, June, October or November. These mass recruitment runs, which last up to 14 days, are heralded as important cultural, social and gastronomic events by many people on Guam. The onset of these annual runs occurs predictably within two days of the last

quarter moon. Known locally as "manahac", the juveniles are caught primarily using small mesh nets (1/2 to 1/4 inch mesh cast and surround nets). The sale of a manahac catch can be an economic boon since approximately 6 lbs. of fish can cost $10 to $25. Some fishing groups have reported selling $6,000 worth of fish in a single day.

Manahac are most desirable as they first arrive on the reef, before the finrays and bones have hardened. Since the fish are eaten whole, they are harvested before they start eating algae, which give them a bitter taste. Specific sizes (lengths) of manahac are given certain names. The size ranges overlap and the naming is somewhat variable. Very small fish (approximately, 40-45 mm) are called "manahac hatang". Larger recruits are called "manahac lesso". *Siganus spinus* recruits as the smaller of the two common species of rabbitfish and also attains a smaller size when full grown. New recruits average about 43.5 mm (FL). Manahac of *Siganus argenteus* average about 60 mm (FL). After eating algae, the manahac are called "dage". Once they become "dage" and until they become approximately 100 mm long the rabbitfish are not considered desirable food fish because the ratio of flesh to bone is small. A fish of this size would be eaten whole and the algae in the gut would impart an undesirable bitter taste to the fish.

Siganus spinus, was identified by Byran (1975), as the most abundant rabbitfish found in Guam's shallow waters. Because of its desirability as a food source and the continued harvest pressure it is prudent at this time to gather information on the biology of *S. spinus*, which could be useful if biological management strategies are being considered at some point in the future.

OBJECTIVES

1) To investigate aspects of the biology and life history of *S. spinus.*

2) To gain the information necessary to assess the need for a management regime

3) To identify a strategy for managing this fishery.

MATERIALS and METHODS

Weekly collections were attempted from October 1984 to October 1985 to collect 10 adult fish from recreational fisherman using weirs and surround nets. In addition, DAWR staff collected fish with spear snorkel at night. The target sample size was selected to facilitate statistical analyses and sampling techniques were selected for effectiveness, simplicity, and ease of execution. The fish weir, a passive collection method, is stationary and permanent, which operates day and night. It is constructed of 1.5 inch mesh chicken wire which acted as a filter allowing newly recruited fish to escape while some immature and all mature fish were captured. Daytime surround net collections were biased toward mature fish since the fisherman selected for them. The least biased technique was night spear fishing since specimens were collected randomly as encountered. The following variables were documented: lunar phase, blotted wet weight, fork length (FL), sex and sexual maturity. The sex of immature fish, those damaged beyond recognition in the process of collection (speared in the gut), and adult fish with the sex unidentified, were classified as undetermined. Measurements were taken to the nearest 0.01 gram and the nearest millimeter.

Sexual maturity was determined by macroscopic examination. Ovaries and testes were staged as follows:

Stage I	*Immature*: gonad threadlike and translucent, of uniform width throughout
Stage II	*Mature developing*: gonad expanded, development beginning anteriorly
Stage III	*Mature unripe*: gonad fully expanded
Stage IV	*Ripe*: gonad fully developed, includes "running condition"
Stage V	*Spent*: gonad empty

Size at sexual maturity was defined as the smallest length class at which at least 50% of all individuals were sexually mature (Stage II or beyond). The chi-square statistic was used to determine whether the sex ratio differed from an expected 1:1 and whether size (in 5 mm FL increments) differed between the sexes.

Harvest estimates for FYs 81-90 were obtained from the DAWR creel survey database and annual reports. The cast net harvest method, which yielded the most representative sample of the population size class distribution, was used to determine the cumulative reproductive size class contribution.

The reproductive contribution was calculated by size class using the following 8 steps: A through H (all steps are applied to each size class, size classes are divided into 5 mm FL increments):

A. Calculated number of individuals: calculate a simple regression equation using the natural log of observed number of females in each size class vs. the median length in each size class. Data are used from the size class at which the collection technique became most effective and larger size classes. Numbers of individuals in smaller size classes are determined by back calculation using the derived equation.

B. Calculated number of females: multiply the percentage of females in each size class by A.

C. Proportion of mature females: the number of mature females divided by the number of individuals in the size class.

D. Calculated number of mature females: multiply calculated number of females by the proportion of mature females (B x C), sum all classes (Sum D).

E. Percent of the total number of mature females: divide the calculated number of females by the sum of the calculated number of females, multiply result by 100 (D/Sum D x 100).

F. Calculated ovary weight: for selected specimens of fish, calculate a simple regression equation using the natural log of the ovary weight vs. the natural log of the FL, for each size class solve for Y using the median fork length value as X.

G. Reproductive contribution per size class: multiply fecundity estimate by calculated ovary weight for each size class.

H. Percent of reproductive contribution for each size class: sum all G values (Sum G), divide each size class G value by Sum G, multiply by 100 ((G/Sum G) (100)).

I. Cumulative reproductive contribution. Progressive sum from the smallest size class, producing eggs to the largest. Value presented will represent the percentage of the total eggs by fish up to the specified size class.

RESULTS

Collections

Because of logistic difficulties and unpredictable field conditions, the prescribed collection regime was not always met. No collections were made in November. Preliminary collections confirmed the catch methods would sample the size classes, which included adult fish.

Sex Ratio

A total of 357 specimens were collected. Of these, 102 were either immature or the sex was undetermined, 143 were male and 112 were female. The sex ratio did not differ significantly from an expected 1:1 ratio ($X^2 = 3.77$, $p = 0.05$, df=1, ns).

Size Distribution

Specimen lengths ranged from 50 to 274 mm FL (Table 1). The largest male collected was 213 mm. Size classes larger than 215 mm were found to contain only females. Mature males were first collected at 85 mm. Mature females were first collected at 116 mm. The ratio of males to females is significantly skewed toward females in size classes larger than 165 mm ($X^2 = 3.841$; $p = 0.05$; $df = 1$; s).

A length frequency distribution (5 mm FL intervals) and numbers of fish were collected (Figure 1). The fish were mature (Stage II and above) and undetermined. Mature males in the 85 mm size class constitute 42.8% of this size class. The first size class to contain both mature males and females is 115 mm. Mature fish comprise 58.8% of this size class.

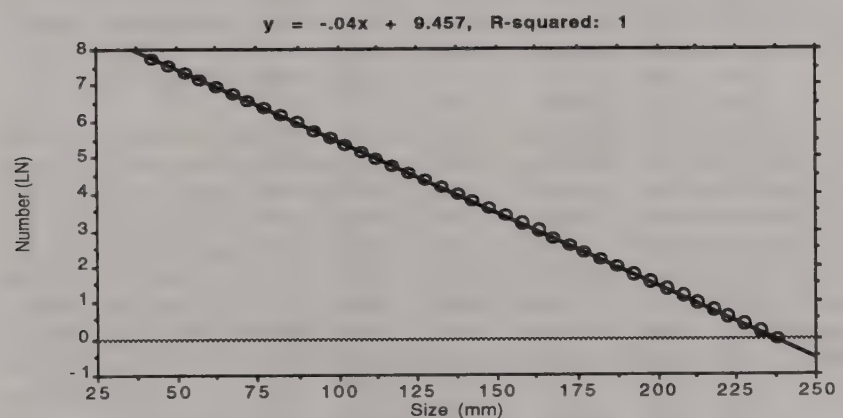

Figure 1. Length frequency distribution (5 mm FL intervals) and numbers of *S. spinus* collected. Data was derived from columns A and B in Table 1.

For the sample population the modal size class was 140 mm FL. This size class contains the greatest number of individuals per size class and is the first size class, which is fully represented in the sample collection. Assuming that the population of *S. spinus* is normally distributed, the smaller size classes should contain the greatest numbers of individuals as would be expected before natural and fishing mortality reduced their numbers. The expected number of fish in size classes smaller than 140 mm was calculated by using the known size class frequency data for classes 140 mm and above and the regression equation: natural log Y=(-.04 (natural log X) + 9.464 obtained from back calculating the

creel survey cast net size distribution data (Y= number of fish in each size class and X= mid point value for the corresponding size class, n=874) Because females get larger than males the calculation was made using only the percentage of females thus incorporating the widest possible range of sizes. However, the number of males could have been used producing equally as accurate results. Since the sex ratio is 1:1, for size classes 165 mm and smaller, the expected number of males and females combined can be determined by multiplying the calculated number by 2. Results are listed in Table 1, column C.

The length/weight relationship for *S. spinus* was tested separately for males and females using regression analysis, natural log of length vs. natural log of weight. The results were analyzed and tested for equivalence using an ANCOVA (Analysis of Covariance) as described in Sokal and Rohlf (1981) (Slope: male = 3.06, female = 2.57; F = 11.788; df= 1,142, p = 0.05; ns). Since the slopes of the regression lines for males and females were not significantly different, length/weight relationship analysis was conducted on a combined set of data. The regression lines for males, females and all fish combined are indicated that the fish grow morphometrically.

Table 1. Size frequency data for S. spinus. A = Size (mm); B = Total Natural Log Number; C = Calculated Total; D = % Maturity; E = Calculated number at maturity; and F = % Population at maturity.

A	B	C	D	E	F
42.50	7.76	2,354.00	0.00	0.00	0.00
47.50	7.56	1,928.00	0.00	0.00	0.00
52.50	7.36	1,578.00	0.00	0.00	0.00
57.50	7.16	1,292.00	0.00	0.00	0.00
62.50	6.96	1,057.00	0.00	0.00	0.00
67.50	6.76	866.00	0.00	0.00	0.00
72.50	6.56	709.00	0.00	0.00	0.00
77.50	6.36	580.00	0.00	0.00	0.00
82.50	6.16	475.00	0.00	0.00	0.00
87.50	5.96	389.00	0.00	0.00	0.00
92.50	5.76	318.00	0.00	0.00	0.00
97.50	5.56	260.00	0.00	0.00	0.00
102.50	5.36	214.00	0.00	0.00	0.00
107.50	5.16	175.00	0.00	0.00	0.00
112.50	4.96	143.00	0.00	0.00	0.00
117.50	4.76	117.00	0.29	33.93	7.73
122.50	4.56	96.00	0.29	27.84	6.34
127.50	4.36	79.00	0.48	37.92	8.64
132.50	4.16	64.00	0.67	42.88	9.77
137.50	3.96	53.00	0.93	49.29	11.23
142.50	3.76	43.00	1.00	43.00	9.80
147.50	3.56	35.00	1.00	35.00	7.98
152.50	3.36	29.00	1.00	29.00	6.61
157.50	3.16	24.00	1.00	24.00	5.47
162.50	2.96	19.00	1.00	19.00	4.33
167.50	2.76	16.00	1.00	16.00	3.65
172.50	2.56	13.00	1.00	13.00	2.96
177.50	2.36	11.00	1.00	11.00	2.51
182.50	2.16	9.00	1.00	9.00	2.05
187.50	1.96	7.00	1.00	7.00	1.60
192.50	1.76	6.00	1.00	6.00	1.37
197.50	1.56	5.00	1.00	5.00	1.14

202.50	1.36	4.00	1.00	4.00	0.91
207.50	1.16	3.00	1.00	3.00	0.68
212.50	0.96	3.00	1.00	3.00	0.68
217.50	0.76	2.00	1.00	2.00	0.46
222.50	0.56	2.00	1.00	2.00	0.46
227.50	0.36	1.00	1.00	1.00	0.23
232.50	0.16	1.00	1.00	1.00	0.23
237.50	0.00	1.00	1.00	1.00	0.23
242.50		1.00	1.00	1.00	0.23
247.50		1.00	1.00	1.00	0.23
252.50		1.00	1.00	1.00	0.23
257.50		1.00	1.00	1.00	0.23
262.50		1.00	1.00	1.00	0.23
267.50		1.00	1.00	1.00	0.23
272.50		1.00	1.00	1.00	0.23
277.50		1.00	1.00	1.00	0.23
282.50		1.00	1.00	1.00	0.23
287.50		1.00	1.00	1.00	0.23
292.50		1.00	1.00	1.00	0.23
297.50		1.00	1.00	1.00	0.23
302.50		1.00	1.00	1.00	0.23
				438.86	100.00

Spawning Seasonality

Spawning seasonality was determined for each month. Spawning activity was based on the percentage of monthly collections in Stages I-V.

Actively reproductive (ripe or spent) fish were found in 7 of the 11 months sampled. No activity was found during January, February, August or September. The peak in activity occurs from April through June.

Seasonal spawning data for ripe and spent males and females separately and both sexes combined (the undetermined category are not included) were determined. Peaks in activity vary between males and females. For males the most ripe individuals appeared in April (66.7%), the most spent in June (31.6%). The most ripe females were found in March (33.3%) and the most spent in May (61.5%). The greatest activity centers in March, April, and May for both sexes. For both sexes combined the greatest number of ripe fish were collected in April (35.3%) and the greatest number of spent fish in May (61.1%). In October only males were collected, 25% of these were spent. In December only females were collected of these 71.4% were spent. No ripe individuals were found in either October or December.

Lunar occurrence of spawning activity

In order to determine whether the spawning activity of *S. spinus* coincides with a particular lunar phase the percentages of actively reproductive (ripe and spent) individuals were examined for each lunar phase. The percentages of collections which fell on each quarter moon phase are as follows: new = 28.6 %, first = 21.4%, full = 7.1%, last = 42.9 %. Ripe and spent individuals were sampled only during collections on the first and last quarter moon phases. Of the collections with actively reproductive individuals 90.9% of them occurred on the last quarter moon. All ripe individuals were collected on the last quarter moon, as well as 83.3 % of the spent individuals.

Nine of the 11 months included in the sampling period had collections, which fell on a moon phase, December 1984 and January through August 1985. Actively reproductive fish were collected in 5 of these months, December, March, April, May, and June.

Ripe males were collected during the last quarter moon of April and May, representing 80.0% and 50.0% of these collections. Spent males were collected on the last quarter moon of May and comprised 50.0% of this sample. Ripe females were collected on the first quarter moon in December (100% of the collection) and last quarter moon of March, April May and June comprising 42.9%, 50.0%, 100% and 75.0% of each collection respectively.

Fecundity

The mean number of eggs per gram of ovary weight was 31,828. Results are listed in Table 2 (Columns C and D).

Table 2. *S. spinus* fecundity with mean number of eggs/g ovary. A = Size (mm); B = Total Natural Log Number; C = Ovaries (g); D = Calculated number of eggs; E = % Reproductive capacity; and F = Cumulative reproduction.

A	B	C	D	E	F
5.00	9.26	3.38	107,578.64	0.59	0.59
10.00	9.06	3.77	119,991.56	0.66	1.24
15.00	8.86	4.15	132,086.20	0.72	1.96
20.00	8.66	4.55	144,817.40	0.79	2.76
25.00	8.46	4.96	157,866.88	0.86	3.62
30.00	8.26	5.40	171,871.20	0.94	4.56
35.00	8.06	5.77	183,647.56	1.00	5.56
40.00	7.86	6.35	202,107.80	1.10	6.66
45.00	7.66	6.86	218,340.08	1.19	7.86
50.00	7.46	7.39	235,208.92	1.28	9.14
55.00	7.26	7.93	252,396.04	1.38	10.52
60.00	7.06	8.52	271,174.56	1.48	12.00
65.00	6.86	9.12	290,271.36	1.59	13.59
70.00	6.66	9.74	310,004.72	1.69	15.28
75.00	6.46	10.39	330,692.92	1.81	17.09
80.00	6.26	11.07	352,335.96	1.92	19.01
85.00	6.06	11.76	374,297.28	2.04	21.06
90.00	5.86	12.48	397,213.44	2.17	23.23
95.00	5.66	13.23	421,084.44	2.30	25.53
100.00	5.46	14.00	445,592.00	2.43	27.96
105.00	5.26	14.80	471,054.40	2.57	30.53
110.00	5.06	15.63	497,471.64	2.72	33.25
115.00	4.86	16.48	524,525.44	2.87	36.12
120.00	4.66	17.35	552,215.80	3.02	39.13
125.00	0.00	18.25	580,861.00	3.17	42.30
130.00		19.18	610,461.04	3.33	45.64
135.00		20.14	641,015.92	3.50	49.14
140.00		21.13	672,525.64	3.67	52.81
145.00		22.13	704,353.64	3.85	56.66
150.00		23.17	737,454.76	4.03	60.69
155.00		24.24	771,510.72	4.21	64.90
160.00		25.33	806,203.24	4.40	69.31
165.00		26.45	841,850.60	4.60	73.91

170.00	27.60	878,452.80	4.80	78.70
175.00	28.78	916,009.84	5.00	83.71
180.00	30.00	954,840.00	5.22	88.92
185.00	31.22	993,670.16	5.43	94.35
190.00	32.49	1,034,091.72	5.65	100.00
		18,307,147.32	100.00	

Reproductive Contribution

The reproduction contribution and the cumulative reproduction of each size class is presented in Table 2 (Columns A, E, and F).

Historic Harvest Analysis

A review of DAWR's historical inshore harvests of *Siganus spinus* for FY86-90, revealed slight occillations from year to year (Figure 2). Harvest totals are exclusive of the seasonal runs of juvenile rabbitfish (*Siganus spinus* and *S. argenteus*). The greatest percentage of length/frequencies were in the 110 mm, 130 mm, and 150 mm size classes.

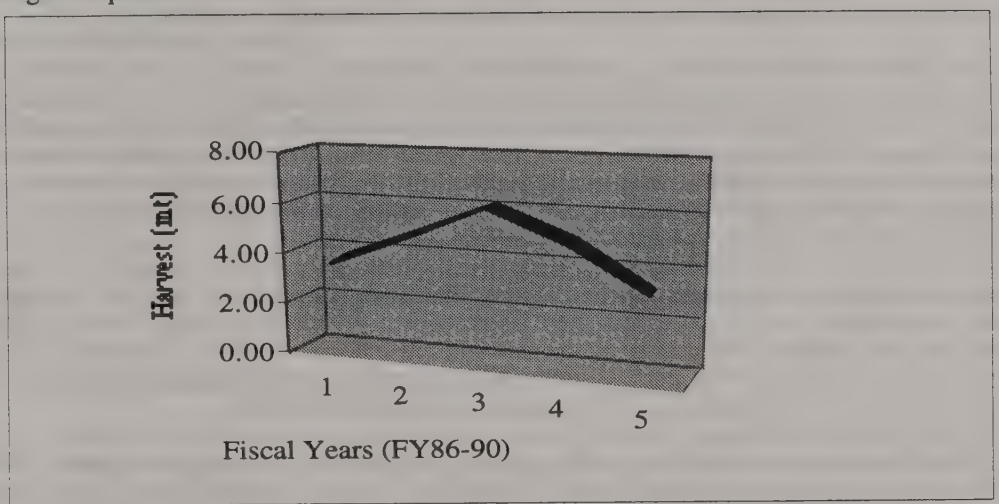

Figure 2. Total annual harvest (kg) for S. spinus from FY86-90. Data was expanded from the inshore creel survey (Job F-1-1-2).

Harvest methods used to catch *S. spinus* are: hook and line; cast net; gill net; surround net; spears; drag net; and other methods. The greatest numbers of fish are harvested with cast net, gill net, spear snorkel, and hook and line methods.

According to the DAWR annual inshore catch report for FY90 (Job 2) the current efficiency of these methods in terms of catch per unit effort (CPUE) in kilograms is: cast net, 0.13; gill net, 1.18, spear snorkel, 0.51; and hook/line, 0.14. The most efficient methods are drag net (6.80) and surround net (4.00).

DISCUSSION

Information gathered in this study on the reproductive biology of *Siganus spinus* is concordant with that reported for other species of siganids. Like many other coral reef

species *S. spinus* was found to spawn over an extended period with specific peaks in activity.

Reproductively active individuals were found in 7 of the 11 monthly collections. Peak spawning activity occurred in March, April and May during the dry season of the year. These spawning times precede the reported juvenile runs of manahac in April/May or May/June (Kami and Ikehara, 1976). Ripe individuals collected in September and spent individuals in October suggest there is also reproductive activity in the rainy season. Although less frequent than the dry season juvenile runs, a manahac run in November occasionally occurs which further supports the assumption of spawning activity in October. Because no collections were made during November and no ripe individuals were found in December, it cannot be determined whether the spent females collected in December spawned that month or were in a resting stage from an earlier spawning period. Although no December or January juvenile run has recently been recorded, archival information at DAWR documents small runs during these months. This documentation, along with the finding of spent individuals, suggest that at this time, some environmental factor(s) is not conducive to larval survival and juvenile recruitment. In an artificial environment of controlled conditions (water quality; salinity, temperature, chemical balance and diet) several species of siganids have been found to spawn in successive months.

Larval survival has been found to be temperature dependent. A drop in water temperature of one degree caused massive larval mortality (Dr. S. Nelson, personal communication, University of Guam Marine Lab aquaculture research project). In the wild, spawning periods may be linked with factors such as food availability, water temperature/salinity etc. Larval survival and subsequent juvenile recruitment may be dependent on sea surface temperature, prey availability and the larval fishes' ability to find and eat these items, as well as wind and currents.

Fish with spent gonads were collected during two moon phases, first and last quarters. The assumption can be made that they spawned on the previous lunar cycles. This suggests that spawning runs occur on the new and full moons. In Palau, Johannes (1981) reported spawning activity for *Siganus canaliculatus, Siganus lineatus* and *Siganus argenteus* to be associated with the new and first quarter moon phases.

Differences in the sex ratio in larger size classes (215 mm FL and larger) may result from differential longevity between the sexes. For siganids in general, females attain larger body sizes (FL) than males. Females were identified with reproductively active gonads at a slightly larger size class than males (115 mm FL vs. 85 mm FL). It may be a selective advantage for females to begin maturation at a larger size because the cost of spawning is greater for females than for males.

Greater than 50% of fish collected were found to be sexually mature at 115 mm FL. It is not presently known whether *S. spinus* attains this size within a year of growth. However, wild caught juvenile *S. spinus* raised in tanks on Guam, reached sexual maturity and spawned in less than one year (S. Nelson, personal communication, 1989). All other species of siganids are reported to reach sexual maturity in less than one year (Duray and Duenas, unpublished; Gundermann, et. al., 1983).

The cumulative reproductive index produced for *S. spinus,* provides a scale from which management recommendations designed to protect a specific portion of the reproductive pool can be based. If ideally, the size which maximizes the production per individual occurs at the age of first maturity when energy is channeled from somatic growth to reproduction, for *S. spinus,* setting a minimum size limit for the 115 mm FL size class would preserve only 0.59 % of reproductive pool. More effectively setting minimum size

limit equal to the first size class at which all females are mature (140 mm FL) will allow all fish to attain sexual maturity prior to being targeted by the fishery. The 140 mm FL size class represents 4.56 % of the reproductive capacity of the population.

A factor, which will provide additional information useful when considering the potential management of a species, is growth. Although initially planned as a parameter for this study using length frequency analysis over time, it was decided to forego this method in lieu of otolith ring analysis. This cannot presently be performed at DAWR.

Harvest of Inshore Reef Fish

A review of DAWR's historical inshore catch records for FY86-89 revealed that the total harvest of *S. spinus* (exclusive of manahac) has fluctuated from year to year. A length frequency analysis of the past ten years (1981-1990) harvest informations showed no change in the size classes of fish harvested. Variation in the numbers of fish recorded from year to year may be an artifact of the application of the survivors' techniques. Based on the catch of *S. spinus* in terms of total finfish harvest, it appears at this time that the population as a harvest resource is stable.

RECOMMENDATIONS

Review of recent and past harvest records show a consistent harvest in terms of kilograms of fish taken and that the size class of fish harvested has not changed. Both of these indicate that the population is presently capable of sustaining itself. Because of its importance in the inshore recreational fishery on Guam and the continued pressure to harvest the juveniles before they spawn and adults with spawning potential, *S. spinus* should continue to be monitored as part of the DAWR inshore survey program. In the event that changes occur in the fishery, because of natural events or additional harvest pressure, which cause a decline in the population, a management plan should be put into effect to:

1) Restore the population to pre-crisis levels.

2) Sustain the population at a level, which would permit a prescribed harvest allowing a maximum take of fish while leaving enough of the population to sustain itself.

The goal of a fisheries management plan should be the establishment of preventative measures to avert overexploitation, which will insure the future of the fishery. In order to accomplish this, protection must be afforded to both adults with spawning potential and immature fish, which have yet to attain their reproductive capabilities. Immature fish should be allowed to grow to the size of first reproductive maturity and to spawn at least once. The following criteria should be established in the following order of priority:

3) Area closures to prohibit the take of fish in areas where they aggregate to spawn and to establish conservation areas where the population can be maintained uninfluenced by harvest pressures.

4) Seasonal closures prohibiting harvest during the two peak spawning periods.

5) Gear restrictions including regulation mesh sizes, net lengths, and gear prohibitions.

6) Minimum or Maximum Size restrictions and/or catch quotas to protect and maintain a percentage of the population's reproductive pool.

Each of these criteria will require review for impact on fish and fishing community. The intent should always be protection of resource and the enhanced use of the resource.

Area Closure

Since *S. spinus* is known to aggregate at specific sites to spawn (channels and reef flats) and because the daily habitat is also known (shallow water reef flats, grass beds etc.), large numbers can be caught with regular predictability. Two types of area closures should be established:

1) Seasonal closures of known spawning aggregation sites during designated months.

2) The establishment of a permanent year round conservation area as a site for a perpetual refuge from harvest thus allowing all size classes an undisturbed lifestyle during all times of the year.

A suitable habitat type for a conservation area would be a wide, shallow bay with places of relief such as rock clusters, coral heads both isolated and extended patches and/or seagrass. This would provide reasonable habitat for new recruits, sub-adults and adults. In addition, a location with seasonal blooms of algae, which coincide with times of manahac runs would further insure the settlement of new recruits, maturation of the young and fulfill the nutritional requirements of older fish within the refuge thus increasing the likelihood the population will stay within the protected area and not forage for food elsewhere. The level of priority and justification for this approach are identical to those expressed under seasonal closures. Although initially, exclusion from a fishing spot may be perceived by fishermen as a loss, presumably the recruitment will increase and therefore so will the availability of fish to fishermen in locations outside the conservation area.

Seasonal Closure

Since *S. spinus* is known to form spawning aggregations with predictable regularity, the prohibition of harvest during these times would allow an undisturbed spawn and assure the production of larvae to seed the next generation. Restriction should apply to times of peak spawning activity in March-April-May. It also is expected that a spawning peak occurs in September-October but the intent of having a closed season is to increase recruitment and it has been only rarely in historical documentation that these fish have recruited at this time. Consideration should be given to limiting closure periods to the first month of spawning to guarantee spawning and then open fishing to allow for maximum use of this resource. The seasonal closure is a high priority approach for this fish because harvest during the spawning season targets the largest fish. The largest size class fish represent the majority of the egg production since they are all females and the relationship between egg production and body size (FL) is logarithmic.

Gear Restriction (Type and Size)

Gear restriction should be placed on the harvest methods, which remove the most immature fish and or have the greatest impact on the reproductive potential. For *S. spinus,* the use of gill nets has the greatest potential to overexploit the immature segment of the population, which needs to be protected from harvest. Once a fish is gilled, it will most likely die in the net making release of undesirable fish an unlikely event. Gill nets are nonselective for species of fish, catching whatever is unlucky enough to become entangled in it. Gill nets are somewhat size-selective in that the optimum size fish to be caught in a certain sized net will have a body depth 1.25 times the mesh diameter. Fish with body depth 20% greater than the perimeter mesh size are not likely to be gilled (Hubert W. A, 1983).

A fish of 140 mm FL will most effectively be gilled in a net of 1.5 inch mesh (38 mm). The next larger mesh size (2 inches or 50 mm) would target on fish 155 mm FL with a body depth of 63 mm. Therefore, a minimum mesh size restriction of two inches should be set to allow a size refuge for maturing and first spawning fish. Although still a very important approach, this is ranked low because from the perspective of reproductive potential, this method will take the longest and have the least direct immediate benefit. Over a long term, this approach is of much higher priority.

Size Restriction (Protection of Reproductive Potential)

The protection of reproductive potential is usually achieved in two approaches. The first order of concern is attempting to assure that all fish reach maturity before entering the fishery. Guam has a very strong fishery on the recruiting juveniles but this does not seem to create a management problem because of the reproductive strategy of this fish. When they recruit, they often will do so in such numbers that they literally starve from lack of available food. With this in mind, the objective is to assure that adequate numbers of those fish, which avoid starvation and capture by fishermen, reach maturity before entering the fishery. This can be accomplished by protecting fish 140 mm in FL and smaller. The 140 mm FL class is the first size class in which all fish are found to be mature. The second approach is to assure that large fish remain in the fishery because a small percentage of very large fish remaining in the population can sustain the required egg production to maintain the population. This is very difficult to accomplish because it generally requires the fishermen to release a large fish.

These proposed steps are specific to *Siganus spinus* and would have to be reviewed independently for any other species to be of value.

It is also recommended that work continue on Guam's important reef fish to obtain the required life history information sufficient to manage any of the key fisheries should they be determined to be in need.

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Report prepared by: Gretchen R. Grimm

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO: F-1
STUDY NO.: 4
JOB NO.: 1

JOB TITLE: Establishing Permanent Marine Conservation Areas on Guam

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

The recent increase in total number of hours fishing and a decreasing catch rate shows that severe pressure is being exerted on the inshore fisheries. The Division of Aquatic and Wildlife Resources (DAWR) recommended the establishment of a Marine Conservation Area (MCA) in Tumon Bay to relieve some of this pressure and ease user conflict in 1989. Since this time the regulations for such an area have been written up and submitted to other government agencies for their input. The suggestions were then incorporated into the regulations (where appropriate) and a legislative bill was drafted. This bill is currently awaiting submittal to the Guam Legislature.

BACKGROUND

In recent years, marine sanctuaries have become an effective tool for managing tropical multi-species fisheries. A sanctuary reserves an area for the protection of marine resources for the enjoyment of non-consumptive recreational users and to provide refuge for breeding stocks that will replenish the island reefs with juveniles.

The DAWR's data base shows that the total harvest for Guam's inshore fishery has decreased by 39% (not including seasonal fisheries) over the past six years (FY84-90). One reason for this decline is the increase in user conflicts. A prime example of this conflict is East Agana Bay. This bay is a popular fishing area for the local residents. Over the past few years, a great deal of animosity has developed between the local fishermen and the jetski operators that are trying to utilize the same area.

Another major reason for the decrease in harvest is due to the large increase of inshore fishing participation. The total number of hours that people have been fishing has almost doubled from 161,602 hours in FY84 to 214,405.1 in FY90. Along with this increase, the average catch per hour dropped from 0.55 kg - 0.27 kg in the same period (not including seasonal fisheries), showing that these fisheries are under severe pressure. Many places have used the sanctuary concept as a way of reducing user conflicts and relieving the pressure that is exerted on the recreational fisheries. An example of a successful sanctuary is Hanauma Bay, Hawaii. In the late 60's, Hawaii experienced a large increase in tourism and heavy fishing pressure. As a result, Hawaii designated Hanauma Bay as a marine life conservation district (sanctuary) where consumptive use of marine life is prohibited, including hook and line, spearfishing, and the collecting of any marine organisms. This area also prohibits all boating activity (including boardsailers, motorboats and jet skis). These prohibitions have lowered the user conflict of the area and appears to have increased

the fish stocks of the area. Out of all areas compared by Kimmerer and Durbin (1975), Hanauma Bay had the highest fish abundance (2320 fish/1000 m2) and biomass (6718 kg./hectare). This area has become so popular that in 1975 it attracted over 20,000 visitors per month.

Tumon Bay was selected as the area to establish an MCA because it has a large habitat diversity representative of the island's reefs, and is equally accessible to residents as well as visitors. Tumon Bay is also an area that will benefit recreational users as well as the fishermen of Guam. This area has well defined boundaries that will allow easy surveillance and strict enforcement.

OBJECTIVES

To study the establishment of one or more MCA's in order to provide a refuge for recreationally important fish so they may grow, mature, and reproduce to increase stock health and recruitment.

PROCEDURES

The following criteria were used for selecting an area for the establishment of a conservation area. An MCA should be established in an area that has a large habitat diversity that is representative of the islands reefs, and is equally accessible to both residents and visitors. It should be in an area that will benefit recreational users as well as the fishermen of Guam, preferably in an area with decreasing fishing pressure. Conflicts between user groups should be minimized while surveillance and enforcement should be vigorously adhered too. Safety is also a major factor in selecting an area for a sanctuary as novice swimmers and snorkelers should be in an area that is relatively free from hazards. The preliminary list of sites for the establishment of an MCA were Cetti Bay, Cocos Lagoon, the "Glass Breakwater" (including "Dogleg Reef" and Luminao Reef), and Tumon Bay. Tumon Bay was selected over the other areas for the reasons described in the FY '89 report.

RESULTS

A formal proposal for the establishment of a Marine Conservation Area in Tumon Bay was prepared and circulated to other government agencies for review and comment. The appropriate comments were then incorporated into a draft bill for legislative action.

RECOMMENDATIONS

Among Guam's most valuable natural resources are its surrounding coral reefs and associated fisheries. In an effort to maintain and enhance these fisheries, the draft bill that incorporates the ideas summarized in the FY89 report will be submitted to the legislature.

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Report prepared by: Timothy S. Sherwood

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT: F-1
STUDY NO.: 5
JOB NO.: 11

JOB TITLE: Permanent Fish Population Transect (Formerly Study 1, Job 11)

PERIOD COVERED: October 1, 1989 to September 30, 1990.

SUMMARY

Preliminary transects established at the reef flat and shallow lagoon sites of Ypao Beach and Luminao Reef during FY89 were monitored. In addition, a preliminary reconnaissance of a lagoon slope reef within Apra Harbor was conducted, but no transects were run there. Results are similar to those for FY89 with high variability and no indication of trends.

BACKGROUND

Effective management of fisheries resources requires an understanding of the effects of fishing pressure on the stocks of target species as well as an understanding of their population dynamics, life histories, ecology, and limits of distribution within the environment. Although harvest estimates for most of Guam's reef fish species are available, little quantitative information on their standing stocks is available. Limited surveys were conducted a number of years ago, but none of these were island-wide in scope, none sampled a complete range of reef zones or habitats, and no attempt was made to obtain quantitative or adequate qualitative information on populations below the practical limits of scuba diving. As the fishing pressure on Guam's recreational reef fishes continues to increase, it is increasingly necessary to obtain quantitative as well as qualitative information on the standing stocks of these fishes and those they interact within a representative range of reef zones and habitats and, if possible, in relatively unexploited as well as highly exploited areas.

OBJECTIVE

To estimate the biomass of recreationally important fishes harvested at Guam and to assess the general status of their stocks in relation to fishing pressure currently exerted on them.

PROCEDURES

Within each reef zone at each site, the following three types of counts of reef fishes were planned:

(1) Visual transects consisting of timed 10-minute replicate counts of all roving species within 5 m of the observer.

(2) 5-minute replicate counts of all territorial and non-roving species.

(3) Counts to the limit of "recognition visibility" of all individuals of "observer shy" or rare species.

For the purposes of this study, only species of special interest as important food fishes or environmental indicators will be counted on some or all transects. Counts of these species may also be broken down into discrete size classes. The species selected and size classes used will be determined after the final selection of methods and sites has been made. It should be noted that several new methodologies for visual counts made by scuba divers have appeared in the literature in recent years (eg. Bohnsack and Bannerot 1985); the potential use of these is being investigated. Depending on the results of field trials, one or more of these may be selected over one or more of the current methods. Other methods that may yield valuable information beyond the reach of visual transects made by scuba divers are also being investigated. These include the use of a remote video camera (operated by the University of Guam Marine Laboratory; this method may eliminate the bias caused by observer-shy species leaving the area of a scuba diver) and a deep-diving submersible. Both of these methods should enable certain kinds of counts to be made to the lower depth limit of the species being investigated.

During FY89 the following three methods were tested at one or more sites for their utility in determining population densities:

(1) 50x10 m belt transects (3 transects; 1 set of counts);

(2) ≥50x10 m belt transects (2 transects; 2 sets of counts);

(3) 10 minute timed counts (2 stations, 2 sets of counts); and

(4) Stationary 7.5 m diameter cylinders (in which fishes are counted in the cylinder of water above a 7.5 m diameter circle around the observer; 4 stations; 1 to 3 sets of counts).

Approximate elapsed times (±0.5 min.) for most transects were recorded to determine the degree of variability in area covered per unit of time. During FY90, only transects for methods 2 and 4 at the Ypao and Luminao sites were monitored. It proved difficult to estimate the length of transects based on timed counts since larger numbers of fishes caused the observer to take more time and cover less area. Although it was difficult to use visual reference points that did not break the surface, replicates of the long transects were run so that endpoints were thought to be approximately the same. This effectively standardized the permanent belt transects to method 2.

RESULTS

During FY90, transects were monitored at the Ypao and Luminao sites established during FY89. At a new site, Dogleg Reef, a preliminary reconnaissance was conducted and a species list was made.

Site descriptions

The Ypao Beach and Luminao Reef sites are described in the FY89 annual report and in Myers (1982), respectively.

Dogleg Reef, Apra Harbor

This is a large hook-shaped coral mound located on the south lagoon slope of Luminao Barrier Reef approximately 600 m west of Hotel Warf. The reef rises steeply from the harbor bottom at a depth of about 35 m to a depth of 1 to 2 m of the surface. The top is relatively flat and the sides slope gently near the top to about 40-60° at depths below 6 m.

Most of the upper surface consists of living coral, primarily *Porites (Synaraea) rus*. The substratum below 15 m consists primarily of rubble and sediment with scattered small patch reefs. The top of the reef is confluent with a fringing reef flat on its western end, but separated from the fringing reef flat on its eastern end by a wide tongue of sand at 6-8 m depth. Large patches of staghorn *Acropora* corals are present at 5-7 m at the western end of this tongue of sand.

One-hundred and seventeen species of fishes were observed here, including 5 species known from previous visits. The top of the reef at 1-6 m depth had the richest fish fauna, with 74 species followed by 32 and 31 species at 6-15 m and 15-30 m down the reef slope, respectively. Only 19 species were found on the fringing reef flat and 21 species on the sand toungue.

Several species of recreationally important foodfishes were present at the site, including the jack, *Caranx melampygus*; snapper, *Lutjanus fulvus*; emperor, *Lethrinus harak*; goatfishes, *Mulloides flavolineatus* and *Parupeneus multifasciatus*, wrasses including a subadult *Cheilinus undulatus*; parrotfishes, (primarily *Scarus schlegeli* and *S. sordidus*); surgeonfishes, and the rabbitfish, *Siganus argenteus*.

The area is used extensively by commercial and recreational interests for non-consumptive as well as consumptive purposes. It has high potential for development as a park, and should that happen, it would be important to establish permanent transects there as well as at a control site.

Transects at Ypao and Luminao Reefs

As in FY89, considerable differences in density were observed between counts and between sites (Table 1) with total numbers ranging from 6 to 150 per 100 square meters.

Table 1. Results of transects run at Ypao and Luminao reefs during FY90. Counts represent selected species of foodfishes in standardized size classes*. Figures are numbers of fishes per 100 m^2. Dates of counts are indicated beneath the station.

Ypao Site							Luminao Site						
Station		small	med	large	v. lg.	total	Station		small	med	large	v. lg.	total
7.5 m diameter cylinder (177 m^2)													
Sta. A : sw. cylinder							Sta. A: e. cylinder						
1/24	1st		no counts				4/4	1st	2.8	12.4	1.7	0	16.9
	2nd		no counts					2nd	1.7	6.8	1.1	0	9.6
5/18	3rd	1.1	6.8	0	0	7.9	6/15	3rd	0.6	18.6	1.7	0	20.9
	4th	0	5.1	0	1.1	6.2		4th	4.0	17.5	2.3	0	23.7
9/11	5th	6.8	29.9	0.6	0	37.3	9/27	5th	2.3	18.6	6.2	0	27.1
	6th	15.8	45.8	0.6	0	58.9		6th	7.3	17.5	4.0	0	28.8
mean		5.9	22.7	0.3	0.3	29.2			3.1	15.3	2.8	0	21.2
Sta. B: ne. cylinder							Sta. B: w. cylinder						
1/24	1st	0.6	45.2	5.1	1.7	52.5	4/4	1st	2.8	8.5	5.6	0.6	17.5
	2nd	0.6	20.3	2.3	0	23.2		2nd	0	13.0	7.3	0.6	20.9
5/18	3rd	0	6.8	6.2	0	13.0	6/15	3rd	2.3	28.8	6.2	0	37.3
	4th	1.1	7.4	5.7	2.3	16.4		4th	13.6	28.8	7.3	0	49.7
9/11	5th	10.7	6.2	18.1	0	35.0	9/27	5th	2.3	23.2	4.0	0	29.4
	6th	7.9	6.2	36.2	0	50.3		6th	2.3	23.2	3.4	1.7	30.5
	mean	3.5	15.3	12.2	0.7	31.7			3.9	20.9	5.6	0.5	30.9

Long transects with area covered

Sta. A: w. transect (90x10m)							Sta. A: inner transect (60x10m)					
1/24	1st	1.3	10.3	3.8	0	15.4	4/4	1st	6.3	17.5	8.5	0	32.3
	2nd	0	9.6	8.6	0	18.7		2nd	4.5	14.2	7.3	0	26.0
5/18	3rd	0.1	7.8	3.4	0	11.3	6/15	3rd	6.2	18.3	5.5	0	30.0
	4th	0.2	5.8	21.2	0	27.2		4th	16.5	17.3	5.8	0	39.7
9/11	5th	7.8	5.7	7.7	0	21.1	9/27	5th	5.5	17.8	4.5	0	27.8
	6th	4.7	7.8	17.9	0	30.3		6th	13.5	18.7	3.5	0	35.7
	mean	2.4	7.8	10.4	0	20.6			8.8	17.3	5.9	0	31.9
Sta. B: e. transect (60x10 m)							Sta. B: outer transect (50x10 m)						
1/24	1st	2.0	31.4	35.6	0	15.4	4/4	1st	0	14.0	30.8	0.2	45.0
	2nd	0	51.2	98.2	0.6	150.0		2nd	0	23.0	38.2	0	61.2
5/18	3rd	0	14.0	18.2	0	32.2	6/15	3rd		incomplete			
	4th	1.2	20.8	39.8	0.8	62.6		4th		incomplete			
9/11	5th	3.0	38.4	24.6	0	66.0	9/27	5th	0	55.8	4.6	0	60.4
	6th	8.0	11.2	48.4	0	67.6		6th	1.6	54.8	13.0	0.2	69.6
	mean	2.4	27.8	44.1	0.2	74.6			0.4	36.9	21.7	0.1	59.1

* Observed fishes were assigned the following size classes: small = 0-7.4 cm FL; medium (med) = 7.5-14.9 cm FL; large = 15-24.9 cm FL; and very large (v. lg.) ≥ 25 cm FL. Data for individual species will be given in the final report.

Both belt transects of 50x10 m or more and 7.5 m cylindrical counts yielded highly variable numbers. This was due to the bulk of the fishes of interest being highly clumped in distribution. This problem was more severe at the Ypao site than the Luminao site. The only solution to this problem is to obtain a large number of replicates and increase the number of stations at each site. In situations where a large number of fishes occur in a small, well-defined space, a reasonably accurate estimate of overall density may be impossible unless the size of the entire site is considered. In that case, a standardized dive in which a large area of known size is covered and all individuals of selected species are counted, may be the only appropriate method.

There is insufficient data and insufficient elapsed time to determine if there are any trends or statistical differences between the two years. Details for individual species will be given in the final report.

RECOMMENDATIONS

It is recommended that this project be de-activated or that its scope and purpose be scaled down to cover only selected sites. If and when it is re-activated, a method of permanently marking endpoints of transects should be found in order to eliminate sources of observer bias, and a data-base software may be required to more efficiently handle and analyze the data (this might require an upgrade of hardware as well).

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Report prepared by: Robert F. Myers

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SUB-PROJECT NO.: 6

JOB TITLE: Construction of Fish Aggregation Devices and Development of a Shallow Water Mooring Program

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

Fish Aggregation Devices

Five nun-style shaped buoy fish aggregation devices (FADs) were deployed during FY90 at the sites shown in Figure 1. Five months following deployment, 4 systems are still on site (with one one being lost in August and another being slightly damaged by a collision with a large vessel). Data on buoy performance and use was collected in several ways: by conducting fishermen interviews (creel census, random interviews), aerial observations, diving and fishing near the FADs. To date, the aerial observations are producing the most useful information on FAD use as well as on-site verification. The remaining have had some success, but need to be modified and performed on a more regular basis. Catches and/or sightings of fish (mahimahi, marlin, yellowfin and skipjack tuna, e'e) around the FADs were noted within the first month following deployment. Poor weather conditions (water temperatures, currents, wind) dampened offshore catches during June through August but communication with the charterboat and other offshore fishermen indicated that during this slack period, the FADs were the only areas that were productive and they were fished on every trip. Fish caught during this time, mostly by jigging and spin casting, included small yellowfin tuna, bonita, and kawa kawa.

Shallow Water Moorings

The popularity of water related activities have caused an increase in damage to the coral reefs due to the setting of anchors. One way that this damage has been reduced in other parts of the world is by installation of mooring buoys. During FY90, mooring design and initial site selection was further modified and mooring equipment was purchased.

FISH AGGREGATION DEVICES

BACKGROUND

A variety of FAD (Fish Aggregation Device) designs have been used by many countries, but the basic design consists of a floating object (buoy or raft) attached to mooring line and held in place by an anchor system. For centuries early forms of FADs, like cork rafts in Malta and bamboo rafts in Japan and the Philippines, have been used to attract pelagic (open water) fish. Due to the apparent effectiveness of these floating objects in the Pacific region, the National Marine Fisheries Service (NMFS) began a pilot program in 1977 around Hawaii to determine if a FAD would attract, aggregate and hold pelagic fish in the area, ultimately increasing the catch of fishermen. Because of the great success of this

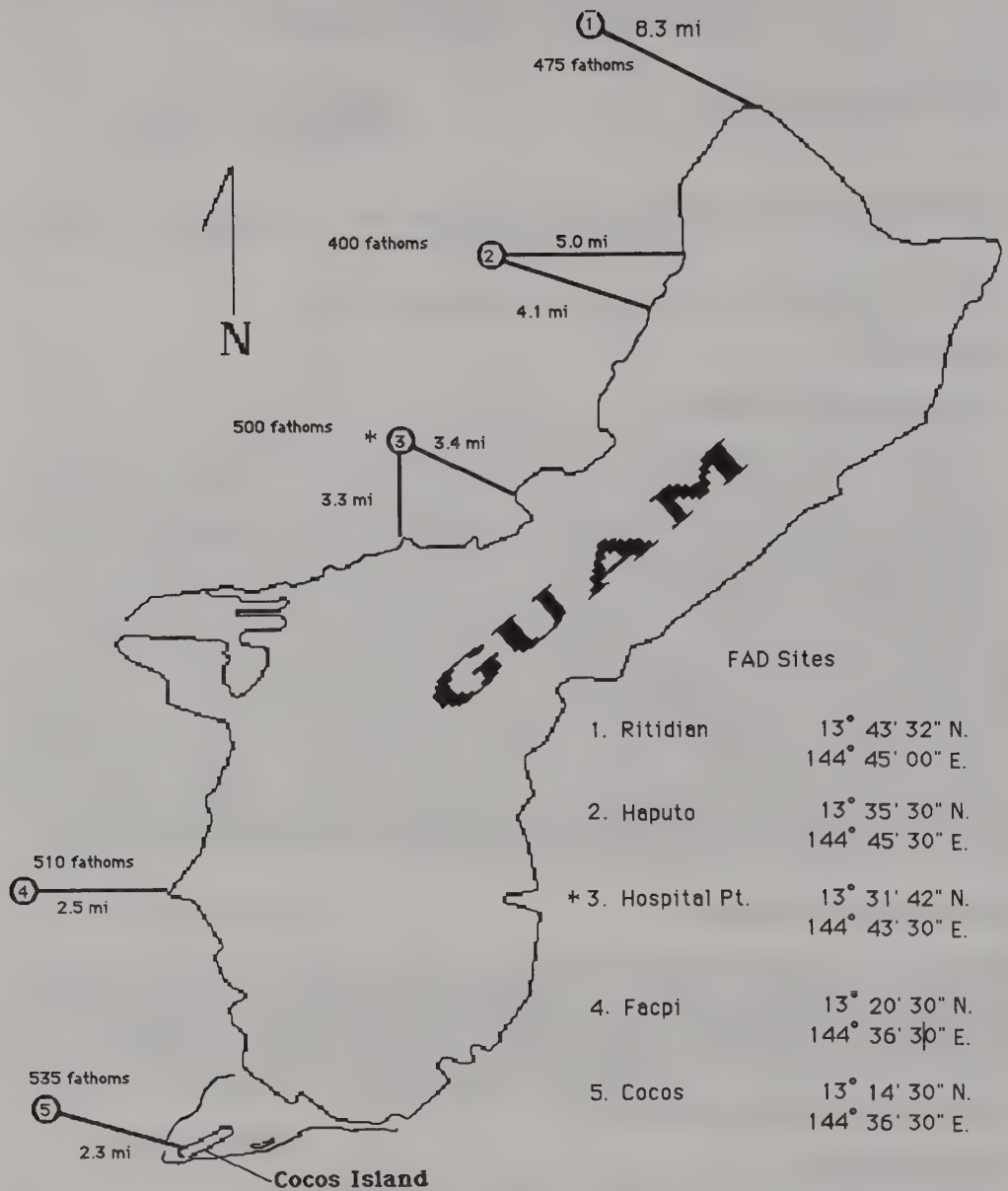

Figure 1. Deployment sites and approximate distance from shore for FADs deployed during April 1990.

*FAD #3 offsite since August 13, 1990.

program, twenty-three (23) Pacific-Basin countries, including the Territory of Guam, had deployed over six-hundred (600) FADs by 1983.

Early FADs have had very short life spans. From 1977 to 1984, the life of the FADs ranged from several minutes (lost during deployment) to twenty-two (22) months. Most often cited for losses of these systems, in decreasing order of importance, were hardware or mooring line failure, severe storm activity, man bite (propeller or anchor damage), fish bite, unsuitable site selection and other unidentifiable reasons. Considerable improvements have been made to the design and maintenance of the FADs in order to decrease the premature loss of the system. The working life expectancy of the FAD is now hoped to be two years instead of an average of nine months for the initial design.

Construction of the FADs in Guam began in 1979, initially under funding from the Pacific Tuna Development Foundation, and was later continued as part of D-J/W-B Sport Fish Restoration program. By the end of FY83, the 10 FAD systems deployed had been lost primarily due to problems involving mooring system design and materials. The FADs have proven successful throughout the Pacific as well in Guam. Reactivation of the program was seen in FY87. Information provided by the South Pacific Commission (SPC) regarding design improvements on the mooring systems and deployment procedures, have been incorporated to increase the longevity by decreasing premature loss of the FAD system. By the end of FY89, five systems were ready for deployment pending calm water conditions.

OBJECTIVE

To enhance Guam's heavily utilized nearshore, leeward fishing grounds through establishment of a system of FADs.

PROCEDURE

FAD Design

The design of the FAD system used during the FY90 deployments is seen in Figure 2. One change made with the FAD design over that envisioned in FY89 (Hensley 1989) was the addition of extra chain underneath the buoy for counterweight. One buoy had an additional 50 feet of 3/4" chain added to the original 50 ft. (for a total of 100 ft.) while the remaining 4 buoys had 65 ft. of chain/per buoy added (for a total of 115 ft. chain/per buoy). Specifications of weight to float the buoy in an upright position were not adequate and additional counterweight was needed. This modification was made during the deployment in order to act as the additional counterweight. All the lengths of nylon and polypropylene made according to the current, depth and substrate conditions (Boy and Smith; 1984) remained unchanged.

Deployment Procedures

Little changes were made to the planned deployment procedure described in FY89 annual report. Three vessels were used in all but the last 2 FAD deployments. The Port Authority of Guam's landing craft, the *Guahan I*, was the main deployment vessel. The Division's 20 ft. vessel, *DAWR*, was used to tow the buoy away from the deployment vessel in order to keep the line straight and taught. The third vessel was the *Island Girl*, a charter boat with depth sounding equipment that had previously performed the site surveys. This vessel located the deployment sites and remained on site until the anchors were released and

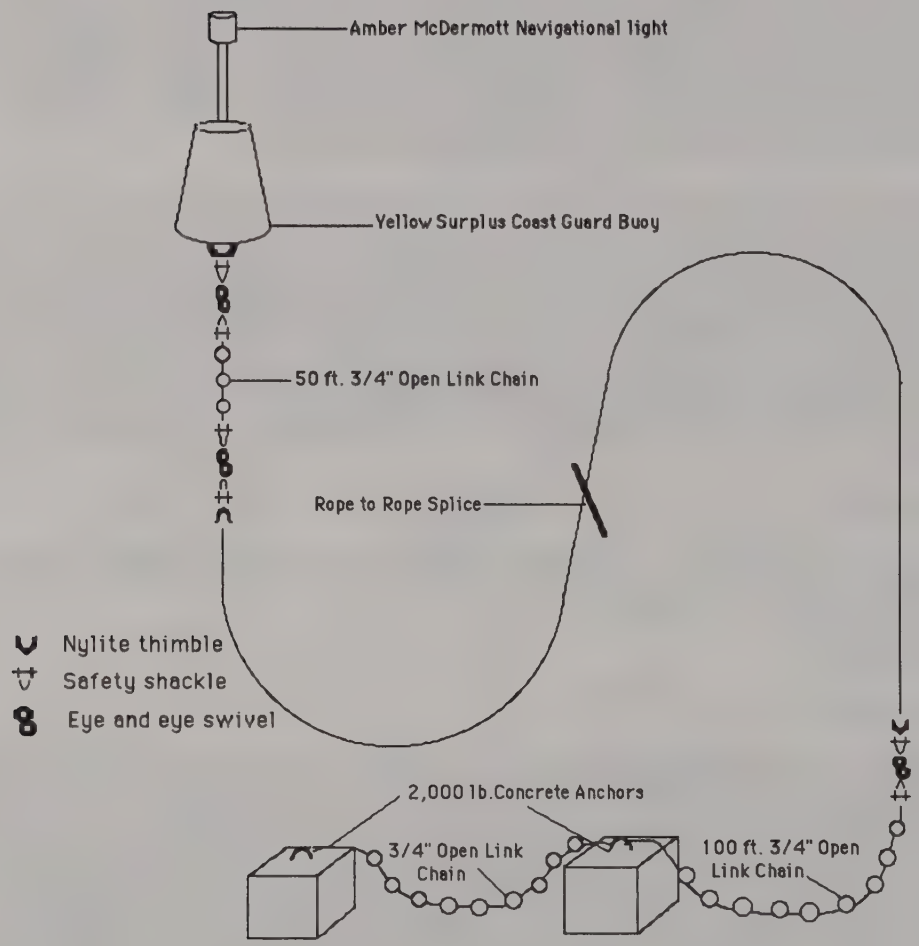
Amber McDermott Navigational light
Yellow Surplus Coast Guard Buoy
50 ft. 3/4" Open Link Chain
Rope to Rope Splice
Nylite thimble
Safety shackle
Eye and eye swivel
2,000 lb.Concrete Anchors
3/4" Open Link Chain
100 ft. 3/4" Open Link Chain

Figure 2. Reverse catenary loop design used in FAD systems deployed during April 1990.

actual site locations were taken. Only two vessels are needed in future deployments where weather conditions (i.e., wind, seas) are calm.

Gear Setup

The entire FAD system consisting of the buoy, mooring system (assembled), and anchor system was loaded on board the deployment vessel (Figure 3) to allow easy deployment and maximize safety. Loading of gear onto the *Guahan I* was contracted through the Port Authority Operations Section but required DAWR staff and *Guahan* crew to facilitate proper loading and gear set up. Slight modifications were made in the placement of the chain than was envisioned in FY89 report. The anchor system (concrete blocks, chain and connecting hardware) was assembled and connected to the mooring line prior to actual deployment. The 2 one ton anchors were placed on the gunwale in the recessed area of the bulwark on top of wooden blocks in order to position the anchors at an angle (30-45 degrees) for ease of release. These were secured with steel cable and a quick release mechanism to facilitate a safe and easy release of the blocks into the water. The buoy was secured on the starboard gunwale, near the stern. Sections of polypropylene (used to secure the chain outside the bulwark during transit to the deployment site) and twine (used as a quick release mechanism for controlled release of chain) were secured to the anchor chain and the upper mooring chain on the starboard side of the bulwark at 10-15 foot intervals. The crate containing the mooring lines was placed against the starboard side of the wheelhouse. The mooring system was prepacked with the polypropylene on bottom and the nylon on top. Both the nylon and the polypropylene ends, with nylite thimbles, were taken out to facilitate easier connection with the chain and shackles. The same procedure for gear setup was used on the port side of the *Guahan* when a second FAD was to be deployed on the same trip. Once all equipment was readied, the vessel left the dock.

FAD Deployment

Upon reaching the general vicinity of the deployment site, the *Island Girl*, identified the actual FAD placement site and remained on station. Once the hardware connections were checked, the deployment vessel began moving past the deployment site. The buoy (without the navigational lights installed) was deployed first, followed by the mooring line. The divisional vessel tied onto the buoy and kept tension in the line until the release of the anchor system. The mooring system was released as the deployment vessel moved away, until the lower one third of the mooring line (flagged with surveyors tape) was at the deployment site. At that time, all vessels were told to stand clear. The quick release system (twine) was used to deploy the bottom chain. Once the chain was deployed, all crew members stood clear, except for the person pulling the quick release mechanism on the anchor blocks. Once the quick release mechanism was triggered, the anchors were deployed. The drag of the mooring line and the weight of the chain was enough to pull the anchors overboard from their angled position in all but one deployment. The use of a lever was needed from inside the bulwark to assist in that anchor deployment. All vessels stayed in radio contact throughout the entire deployment process. The buoy and mooring line acted as a parachute for the anchors and took an average of 6 -7 minutes before the buoys stopped moving. This indicated that the anchors were on the bottom. Once the movement of the buoys stopped, the navigational light was installed. A site location was then recorded by the chartered vessel.

After the first FAD was deployed, the remaining 4 FAD systems were deployed, 2 per day. The positioning of the gear on the Guahan was similar to that discussed above except both starboard and port sides were used. The anchor blocks were placed in the second gunwale

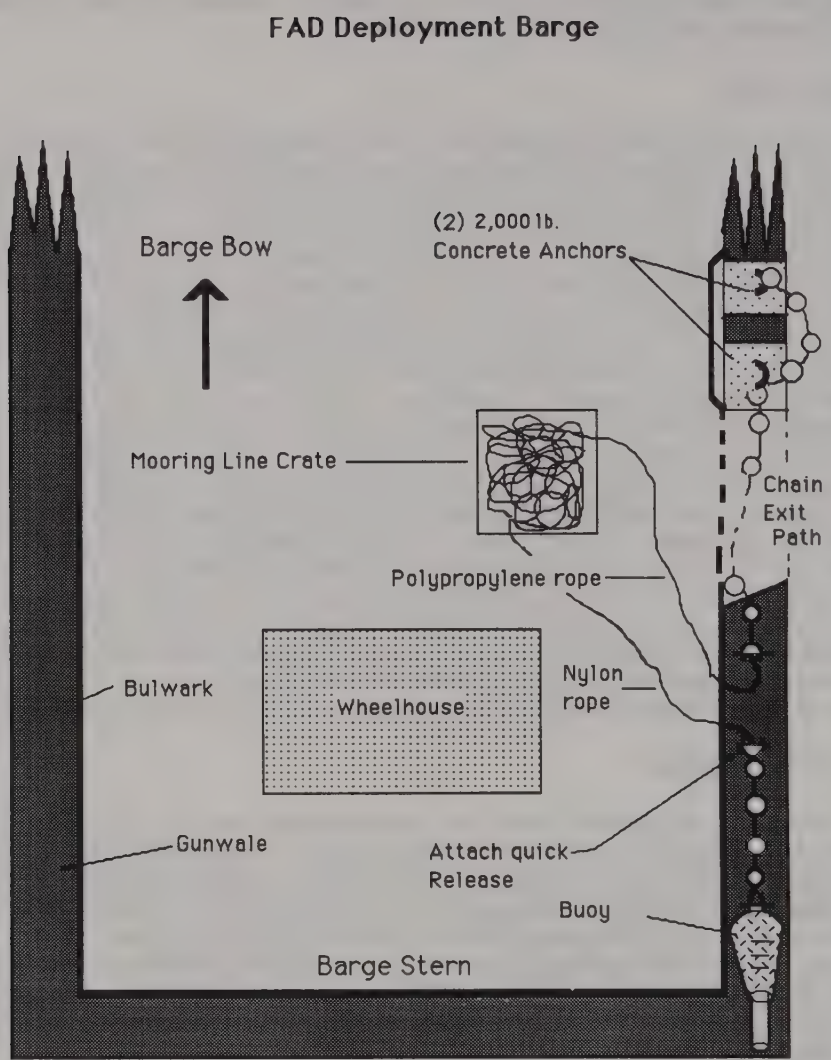

Figure 3. Equipment layout on the FAD deployment vessel, the Guahan I.

so more of the anchor chain would be outside the bulwark making the systems safer and easier to deploy.

FAD Maintenance and Monitoring

Data collection, for FAD position and fishing activity, was initiated using several techniques: aerial surveys (currently being used for inshore fishing activity verification), offshore creel surveys, and incidental fishermen interviews. To expand on the effectiveness of the FADs, monthly boat trips were planned for maintenance and monitoring of the FADs. On these trips, DAWR personnel primarily did routine maintenance, if necessary, observed fish in the vicinity of the FAD, did counts if feasible and fished the area for predators.

RESULTS

The five FADs were deployed in 1990 on the following dates: Hospital Point, April 18; Ritidian, April 23; Haputo, April 23; Facpi, April 30; Cocos, April 30. The FAD numbers were redesignated as to position with the most northerly FAD (Ritidian) designated as #1 and the most southerly FAD (Cocos) as #5. After deployment, the positions were verified by SATNAV equipment onboard the *Island Girl* and reported to the Coast Guard (Notice to Mariners report), the Army Corps of Engineers and to the public through the press (Figure 1). Mooring lengths for each FAD site are listed in Table 1 and costs per FAD are listed in Table 2.

Table 1. Length of mooring system with calculated nylon and polypropylene lengths used in FAD systems deployed during April 1990.

MOORING SYSTEM LENGTHS (ft)			
Site	Nylon	Polypropylene	Total Length
1 (Ritidian)	1,214	2,426	3,640
2 (Haputo)	875	1,965	2,840
3 (Hospital Point)	1,214	2,426	3,640
4 (Facpi)	1,352	2,812	4,164
5 (Cocos)	1,348	2,992	4,340

Fishing Activity

Information was gathered as part of the offshore creel surveys has not been as informative as it should be in the future. Part of this is due to the short time period that the FADs have been deployed and to the lag period for training personnel when initiating new questions into the survey. Most FADs have a 3 months lag period before they begin to function effectively (G. Davis, pers. comm.). Within the first month following deployment, creel surveys and communications with fishermen, reports of occasional fish catches around each FAD included marlin, mahimahi, yellowfin and skipjack tuna. Reported catches by August, often by jigging and spin casting instead of trolling, included catches of kawa

kawa, small yellowfin and many skipjack tuna. During June through August, the FADs were one of the few places that offshore fishermen were able to catch fish without going to the offshore banks.

Table 2. Itemized FAD costs (for the five FADs deployed in Guam in 1990).

QUANTITY	ITEM	COST ($)	COST/FAD ($)
14 (2000 lb.)	cement blocks	4000	571.43
14 (tear drop)	buoys	7000	500.00
10 (2 sets of 5)	mooring systems	26,860.00	2,686.00
10 systems	shipping costs	2,564.64	256.46
16	buoy lights	2,740.66	171.29
5 (deployment)	vessel/barge	8,292.20	1,658.24
5 (locations)	depth sounding	5,000.00	1,000.00
5 (1 1/4' anchor shackles)	2 " gap for buoy	175.25	35.05
TOTAL COSTS*		56,632.75	6,878.47

*Cost is exclusive of equipment transport and use of Division personnel.

These surveys indicate a pattern of fishing, at least among FADs #1-3. After the initial deployment of the FADs, the FAD alley (either FAD or area between each FAD) was fished, either upon leaving or returning trip, with the 40-50 fathom contour being used as the alternate route. Toward the end of this fiscal year (August and September), most aerial observations noted use of the FAD alley on both out and inbound trips. A change in the FAD usage with a shift to fishing in more southerly areas has also occurred since the opening of the Agat Marina. This needs to be more closely monitored for consideration of future FAD sites.

Other FAD Activity

Most of the fishing being done near the FADs has been trolling. Reports of people jigging, spin-casting, drift fishing and night fishing with lights has occurred. One instance of an individual interested in gill netting around the FADs has been noted. Observations of purse-seiners and longliners in and around the FADs (especially Cocos and Ritidian) have been made during FAD trips, aerial surveys, and creel surveys. On at least two occasions, illegal commercial fishing activity was probably occurring.

Visual Observations of FADs and Fauna

Visual observations and diving near the FADs during five months following deployment show that juvenile jacks (*Caranx sexfasciatus*) were some of the first fish to appear around

the buoys. *C. sexfasciatus* was observed within first two weeks after deployment and appeared to increase in number as the FADs were on station. Other fish that were seen during monitoring trips include at least three Carangids (*Decapturus sp., Caranx sp., Elagatis bipinnulatus*), mahimahi (*Coryphaena hippurus*), tripletail (*Lobotes surinamensis*), triggerfish (*Canthidermis maculatus*), and damselfish (Pomacentrid).

Inspection of the FAD gear revealed little wear on any of the gear except some pitting on the cotter pins of the safety shackles. It was noted that there was some vibration in the chain during inspection. The McDermott Navigational lights were operational for all buoys checked except for the Ritidian FAD (#1). This buoy had apparently been hit by a large vessel. The only damage was a small dent in the buoy and the destruction of the navigational light. After replacement of the light in May, no other incidents were noted. Additional sites are being investigated for new FAD deployments including the eastern side of Guam, Pati Point and areas around Agat.

Project Status

During FY87-89: see Hensley 1989 and during FY90:

a) Deployed five buoys systems. Costs per FAD are listed in Table 2.

b) Began monitoring fishing activity through creel and aerial surveys.

c) Initiated monitoring fish population through skin diving, visual observations, and fishing techniques.

d) Initiated monitoring/maintenance program for the FADs to correct any wear and tear on hardware, light systems, etc. in order to decrease chances of buoy loss.

e) Began purchasing equipment for replacement FADs and future deployments.

f) Began analysis of areas for future deployments of FADs (through creel surveys, aerial surveys, fisherman preference, etc.)

g) The Hospital Point FAD was lost around 13 August, after 118 days on station. Initial attempts to recover the FAD were delayed due to weather conditions on the eastern side of the island.

RECOMMENDATIONS

Because of the use of the FADs by the local fishermen and their apparent satisfaction of the FADs effectiveness, it is recommended that this project be continued. During the next fiscal year, it is recommended that all lost FADs be recovered, if possible, in order to determine reason for loss. The lost FAD(s) should be replaced, as long as the reason for loss is not due to problems with site selection (i.e., current, depth, etc.). Detailed records should continue to be kept to facilitate changes in future FAD systems, where necessary.

The monitoring of fishing activity around Guam, through existing creel surveys, aerial surveys and incidental fishermen interviews should continue in order to better analyze the FAD and non-FAD use, especially for future deployments. Improvements should be made in the sampling regime to compare fishing in FAD and non-FAD areas. These include modifications in the questions on the offshore creel surveys as well as monthly

observations of the FADs for aggregated fauna (both through snorkel, scuba and fishing). General maintenance should be included during these inspections of the buoys (i.e., navigational light, upper mooring inspections, buoy position). Tagging of fish caught around the FADs should be investigated to determine if the fish population is stationary near any one FAD or migrates between FADs.

Additional sites for the future deployment should be selected. Because of the pending construction of boat ramps on the eastern side of Guam, this is the area that needs to be investigated for future FAD sites. Other areas to include in selection of sites are the northern portion of Guam, near Pati Point. Once sites are selected, the government review and permitting procedure should be initiated.

On all future deployments, modifications and changes that were suggested at the South Pacific Commission's 22nd Regional Technical Meeting, 1990, should be incorporated. Some of these modifications include adding zinc plates for corrosion, adding a counterweight to eliminate extra chain under the buoy, changing all cotter pins to stainless steel, changing the nylon to polypropylene splice from a '2-in-1' splice to a tuck splice, tack welding anchor shackles with carbon steel weld and changing the anchor shape and internal hardware to reduce cracks in the concrete from internal vibration. Other modifications should be incorporated for the navigational light, including increasing the bulb size for better illumination and utilizing silicone between the batteries as an inhibitor of electrical shorts. Attendance at future FAD meetings is in order to better facilitate information transfer and incorporate this information into the FAD program in order to increase lifespan of the systems.

SHALLOW WATER MOORINGS

BACKGROUND

Many boaters have a favorite spot where they anchor to dive or fish. The DAWR has received many reports of damage to the reef caused by anchors. It has been estimated that over 30% of anchor settings on coral reefs cause damage (Halas 1985). Some boaters place "home-made" moorings to avoid the problem of anchors getting fouled in coral. "Home-made" moorings are constructed with concrete or automobile parts as an anchor and a buoy connected by chain. These moorings are then haphazardly placed in the general area of heavy coral growth. Storm swells move these moorings around and thereby destroy large amounts of coral. In addition to the storm movement, slack in the chain during low tide causes damage in the immediate area of the mooring. Due to the slow growth of corals, it takes years to repair the damage. This damage not only affects the corals in the immediate area but also decreases available habitat for other marine organisms.

Halas (1985) studied this problem in the Florida Keys and designed a mooring buoy program that prevents excessive anchor damage to the reefs. Halas' mooring design incorporates an 18-inch deep hole that is drilled into the reef. An eyebolt is cemented into this hole and a mooring line is attached to it. The mooring line runs through the center of the buoy and the end of this line is used as a pick up line by the boaters. Halas placed some of the moorings in areas that were not previously utilized. In conjunction with the mooring buoy program, Halas has printed handouts that describe the areas around each mooring. This program has become such a great success that it is now being extended beyond the park boundaries and has been adopted by islands in the Caribbean and Hawaii. The Halas method will be applied in areas with hard substrate. The anchor system

proposed for sandy areas will utilize auger type anchors that were originally designed to cork-screw into the ground to secure guy lines from telephone poles.

OBJECTIVES

To establish a shallow water mooring program to minimize coral damage in common boat anchoring areas and to enhance fishing access in areas with anchoring difficulties.

RESULTS

Modifications have been made to the Halas design for use in Guam's waters. In Halas' system, the upper portion of the mooring system consists of a spherical polyethylene plastic filled buoy and a polypropylene pickup line that are attached to a polypropylene line. In Florida, there is not a problem with theft of these buoys partly because of the constant monitoring that occurs within the marine parks. Because of the difficulty of monitoring the mooring systems on Guam, it was decided to change the upper mooring design to impede problems with theft. A Topper buoy system (foam filled tire with a 6 ft. length of 3/8 in. galvanized chain assembly with a galvanized pickup ring attached) will replace the upper portion of the shallow water mooring system. Even though the cost of each mooring will increase, this should make the mooring easier to see and harder to steal.

Tentative sites for placement of these shallow water moorings are Double Reef, Piti, Apra Harbor, Anae Island, Sella Bay, Cetti Bay. Further sites will be selected prior to initiating the permitting process in order to decrease the time required for government review and permitting procedure. Installation of the first systems should be completed by the end of the FY91 as long as the permits are acceptable by the Army Corps of Engineers and the Government review process.

Project Status

During FY89:

a) A literature search was conducted for basic knowledge of shallow water mooring systems.
b) Fourteen (14) trial auger type anchors were donated to DAWR by the Hawaii Sea Grant Program.

During FY90:

a) Initial mooring sites were selected.

b) Topper mooring buoys and chain assemblies were purchased for 30 systems.

c) A time frame for completion of permits and initial installation was developed.

RECOMMENDATIONS

1. Develop installation and maintenance methodologies.

2. Deploy sand bottom mooring systems as soon as permitting procedure allows.

3. Investigate acquisition of underwater hydraulic drill for use in hard substrate with stainless steel eyebolts instead of augers.

4. Purchase additional equipment as necessary.

LITERATURE CITED

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Report prepared by: Rebecca A. Hensley

PROJECT SEGMENT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SUB-PROJECT NO.: 7

JOB TITLE: Construction of Boating Access Facilities

PERIOD COVERED: October 1,1989 to September 30, 1990

SUMMARY

Construction of the Merizo Pier will begin pending the successful review and granting of necessary permits from local and federal agencies. Construction is slated to begin during FY91. Boat launching ramps proposed for sites in Inarajan and the Piti Harbor of Refuge will also require permits prior to construction. This process is in progress.

BACKGROUND

As initially proposed the objective of the Merizo Pier project was to repair and extend the existing pier. An inspection of the existing pier revealed that the structure had deteriorated to the extent that renovation was impractical. The scope of the project was revised to the design and construction of a new pier during FY88.

During FY89, plans for the construction of a replacement pier in Merizo were finalized and the construction company International Bridge and Construction, (IBC) was retained as of September 26, 1989. A total of $382,208.80 has been encumbered on this project. No date for the beginning of construction has been announced.

OBJECTIVE

To increase boating accessibility to fishing grounds through the creation of safe, strategically located boat launching facilities.

RESULTS

During FY90, plans for the construction of a replacement pier in Merizo were suspended pending clearance from local and federal review agencies, which require a site-specific permit before construction can begin. Those agencies are: Government of Guam, Department of Land Management, Bureau of Planning, and the U.S. Army Corps of Engineers. Because the Merizo Pier is located within the Guam Territorial Seashore Park, a clearance permit must be obtained from the Territorial Land Use Commission. An application must be submitted to the Bureau of Planning, to insure that coastal zone guidelines are followed. A U.S. Army Corps of Engineers permit is required because construction plans call for dredging more than 10 cubic yards of pavement. The IBC was retained as of September 26, 1989. This corporation is still on contract. IBC will be granted permission to commence construction as soon as permits are issued. The aforementioned permitting process is also required for construction of boat ramps in Inarajan and the Piti Harbor of Refuge. Information necessary for the completion of these applications is presently being gathered.

RECOMMENDATIONS

The Merizo Pier project should be carried through to completion during FY91 and the boat ramp projects initiated. Construction time for the pier is estimated to be less than six months from onset of activity.

An assessment should be made of the need for development and/or enhancement of existing facilities as well as identification of as yet unutilized boating access locations. Enhancement projects might include placement or maintenance of channel markers or buoys, onshore lighting (floodlights to illuminate access areas), navigational aids and parking lot improvement. Identification of new sites might be facilitated through analysis of demographic distribution of boaters in relation to existing facilities to determine where a need exists for more conveniently located ramps and piers and a review of the reefs and bays of Guam to identify geographic locations with natural features suitable for development as boating facilities.

Report prepared by: Gretchen R. Grimm

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SUB-PROJECT NO.: 9

JOB TITLE: Inshore Fishing Access Facilities

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

During FY90, the reef fishing platform design was further explored to provide facilities for inshore fishing access. Sixty-seven areas around Guam have been field surveyed for fishing platform sites. Fiberglass has been selected as the preferred construction material for the reef fishing platforms. Five engineering firms have been routinely contacted to incorporate their ideas into a proposed design. We will be submitting an environmental impact assessment to the U.S. Fish and Wildlife Service and other agencies for review. The proposed design will then be put out on bid to secure an engineering firm who will finalize the design plans. Approval to build the fishing platforms at selected sites will be sought through Government of Guam agencies and the U.S. Army Corps of Engineers (ACOE). After the permitting process has been completed, the project construction will be put out on bid. Any additional information like substrata analysis, if required, will be sought prior to the construction phase.

BACKGROUND

Historically, reef flat fishing has been a way of life for Chamorros. Many local people still fish Guam's shallow waters both for food and recreation. Every year, a number of drownings and near-drownings take place due to hazards associated with fishing. To provide a safer environment and to both increase and enhance hook and line sportfishing opportunities, reef flat fishing platforms have been proposed for Guam.

Traditionally local fishermen have constructed platforms in shallow sandy areas. Typically, platforms have been fabricated with "tangan-tangan" poles with a floor of split bamboo lashed to the frame. Frequently, the platforms have two levels to their construction. The first level gets the person fishing off the water to keep dry and provides for a vantage point to view any fish swimming in the area. The second level provides a place for the person fishing to sit and the space below can be used to store fishing equipment not being used. The placement of platforms are usually near channels or rips to take advantage of fish migrating over the reef to feed during tidal fluxes.

The concept of fishing platforms can be transferred to areas with hard substrata to increase fishing opportunities. Presently, there are favorite inshore and reef fishing areas where people fish because of the shoreline topography or water circulation patterns. Fishing platforms should be located in areas where people cannot fish regularly now due to the existing conditions, in areas that pose a safety problem for people who want to fish, or to make a temporary existing structure more permanent. Fishing platforms built to withstand the natural conditions of the area would allow usage in areas that are typically unsafe.

OBJECTIVES

Plan and design inshore fishing access facilities on the windward coast of Guam and research the possibilities of alternate sites on the leeward coast (reef flat platforms, and cliff platforms)

PROCEDURES

The Division of Aquatic and Wildlife Resources (DAWR) has been actively evaluating and surveying sites using five established criteria for locating fishing platforms.:

(1) The sites should have a solid limestone anchoring base for the platform with no coral present or provisions must be provided to anchor them securely in the sand.

(2) The site should be accessible so that people can reach the platforms easily to fish.

(3) The sites should be close to deep-water areas with known fishing potential.

(4) The platforms should be placed in areas that would cause minimal environmental damage to the existing substrata.

(5) Location of platforms should take advantage of unique features like a peninsula coral heads, reef cut, channel or bays where fish may congregate.

Fishing Platform Design

The design of a viable fishing platform has been a challenge. The fishing platforms will need to withstand constant wave activity, salt water corrosion, remain dry on top during daily tidal fluctuations and allow enough area for the people fishing to move around for casting. The platforms should be designed to use a minimal amount of substrata area, be easy to maintain, provide an increased margin of safety while fishing, allow the construction to be completed by only a few people and using minimal construction paraphernalia. To assist us this past year, we focused our attention on five engineering companies that were identified from our work last year with the proper interest, background and experience. The sketches submitted for the reef fishing platforms were for platforms either constructed of concrete or fiberglass. The latter is the preferred choice for a platform because of its lightweight, high strength, and anti-corrosion properties.

There are other types of inshore access facility designs that have been considered. An overhang fishing platform is a design that we would like to work with in the future. The breakwater fishing platform has been suggested by a local engineering firm. It involves a walkway extending out to the reef edge and/or drop-off from a raised shoreline or breakwater. At this time, our reef platform design has received the highest priority.

RESULTS

To date, sixty-seven areas have been evaluated for fishing platforms. Twelve areas are actively being considered for reef fishing platforms around Guam: (1) Ajayan Bay, (2) Togcha Bay, (3) Piti Bay (Tepungan Channel), (4) Asan Bay, (5) Inarajan Bay, (6) Agfayan Bay, (7) Pago Bay, (8) Toguan Bay, (9) Togcha Beach Cut, (10) Umatac Bay, (11) Talofofo Bay, and (12) Ylig Bay. The Togcha Bay, Asan Bay, and Togcha Beach Cut are all cuts in the reef margins that allow the water to drain or flush the reef flats during tidal fluctuations.

Fishing Platform Design

The design of the reef fishing platform (Figure 1) has proceeded to the point of having defined specifications that will be presented in the "Request for Proposal". The platform will be built with fiberglass members and bars manufactured by the pultrusion process. In its simplest terms, pultrusion is the process of pulling fiberglass (or other) reinforcements through a "bath" of thermosetting resin and into a heated forming and curing die to produce composite structural shapes. To protect the fiberglass from UV light, it will be covered with a coating that will protect it and/or UV light inhibitor will be added to the resin. The platform will be six feet by six feet to eight feet by eight feet with a hand railing (3.0'-6.0") and will stand six feet off the limestone substrata with two vertical or four slanted legs. There will be a ladder to the top of the platform. It will be adequately built to handle a significant amount of wind and/or wave load. The legs of the platforms will be attached to an imbedded fiberglass anchor and plate in a specially designed corrosion resistant concrete base with at least 3000 PSI strength, low water to cement ratio, and reinforced with synthetic fibers for added strength.

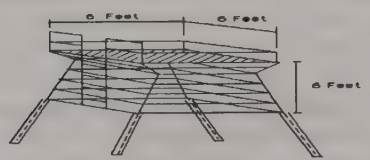


Figure 1. Fishing Platform design model.

DISCUSSION

We had five established criteria for locating fishing platforms and are all still valid. They were discussed at length in last year's annual report (Kruckenberg, 1989). There are definitely sites available that meet all of the outlined criteria. After the reef platform design has been finalized by an engineering firm, the exact sites will be chosen for them. The approval to build the fishing platforms will be sought through the Government of Guam agencies and the ACOE. This process will require the preparation of an environmental impact assessment. After the permitting process has been completed, the project construction will be put out on bid. Any additional information like substrata analysis, if required, will be sought prior to the construction phase.

Most engineering companies on Guam deal with concrete construction and some have vast experience in the salt water environment. There have been some reef fishing platform sketches submitted using concrete. Building the platform with concrete has not been the preferred choice of building materials. This is because concrete beams are heavy, the logistics of pouring large concrete piles on the reef edge can be expensive, a concrete structure set loose by a major typhoon could do a lot of damage to the reef environment, oxygenation of water in the splash zone and salt water corrosion may have an effect on the concrete and supporting rebar by significantly shortening the longevity of the fishing platform.

We have been concerned about keeping the design of the fishing platform under our control and done in such a way that would be both environmentally sound and kept within our budget constraints. The fishing platform design and construction phases will be put out for bid to insure that the project is cost-effective and done by the most qualified company. By

communicating regularly with various engineering firms during the year, we should have some local firms ready to assist us.

RECOMMENDATIONS

1. This program has valuable traditional fishing application for Guam; it addresses the safety factor and enhances both hook and line fishing opportunities. We therefore recommend that this job to construct fishing platforms around Guam continue.

2. During the next fiscal year, we should be able to finalize plans for our shoreline fishing platforms and anchoring system. To initiate the process, an environmental impact assessment will need to be submitted to the U.S. Fish and Wildlife Service and other agencies for their review. After their approval, the proposed design will be put out on bid with a local engineering company. When the plans are completed, we will initiate the permit process to get site approvals and/or comments from various Government of Guam Agencies and the ACOE about our proposal to construct fishing platforms. After the permitting has been completed, the project construction will be put out on bid.

LITERATURE CITED

Kruckenberg, Wayne L. 1989. Annual Report Fiscal Year 1989. Division of Aquatic and Wildlife Resources, Dept. of Agriculture, Government of Guam.

Report Prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

JOB TITLE: Giant Clam Transplantation

PERIOD COVERED: October 1, 1989 to September 30, 1990.

SUMMARY

One-hundred broodstock (5 year old) giant clams (*Tridacna derasa*) were obtained from the Micronesian Mariculture Demonstration Center (MMDC), Palau during the last quarter of FY89. Seventy-two of them were placed in unmarked sites within Apra Harbor between Sept. 20 and Oct 12, 1989 and the remainder left at the Guam Aquaculture Training and Development Center (GATDC) at Fadian (herein referred to as the Fadian facility). Twelve clams were placed at each of four Apra Harbor sites, 6 each at 5 and 10 m depths, respectively (Figure 1). The clams left at the Fadian facility were moved to a tank with inadequate water flow without our knowledge and became moribund or died by early January. Fifteen of the 27 that were still alive were immediately placed in 10 m of water at the Glass Breakwater site. By late February, most or all of the clams at all the 5 m sites except Sasa Bay and possibly a few of those at the 10 m Glass Breakwater sites had been poached, so those remaining were placed in 10 m. By mid-June, all clams at the Glass Breakwater sites had been poached, leaving only those at the Sasa Bay and Jade Shoals Sites. All clams still present were measured during February. Positive growth was noted and all appeared healthy and free of either parasites or evidence of attempted predation.

BACKGROUND

Species of giant clams of the genus *Tridacna*, are an important traditional food as well as a potentially valuable export commodity for Asian food markets and the worldwide aquarium trade (Copeland and Lucas, 1988). During the past 3 decades, giant clam stocks on most coral reefs have become seriously depleted. Three species are native to Guam: *Tridacna maxima*, *T. squamosa*, and *Hippopus hippopus*. The largest species, *T. gigas* is known from Guam only on the basis of fossils, and apparently went extinct before the arrival of humans. *T. maxima* was once quite common on reef flats as well as clear-water reef slopes, but has become scarce or disappeared on most reef flats. *T. squamosa* and *H. hippopus* are quite rare, and generally occur in less accessible habitats.

All species of *Tridacna* and *Hippopus* are phototrophic, that is they harbor single-celled plants (zooxanthelae) that manufacture most if not all of the clam's nutritional requirements. The clams therefore require relatively shallow, clear water with good exposure to sunlight, but do not require supplemental feeding. When under about 6 to 10 inches valve width, they are prone to predation by certain fishes (primarily rays and large triggerfishes and puffers) and drilling parasitic gastropods. Larger clams and those of reproductive age (5+ years) are relatively immune to predation.

In recent years it has been demonstrated that giant clams may be effectively cultured and transplanted (Heslinga, et. al., 1990). The species *Tridacna derasa*, second only to *T. gigas* in size, has proven to be the most feasible and fastest-growing as well as most readily available from a hatchery. It is well adapted to lagoon environments, which can be

monitored more easily than exposed seaward reefs. It therefore has the best potential for becoming established as a fishery resource.

OBJECTIVE

To introduce and establish the giant clam *Tridacna derasa* on the reefs of Guam.

PROCEDURES

Procedures for site selection, processing and field placement, and monitoring are given in the FY89 annual report and remain unchanged from that year.

RESULTS

Seventy-two of 100 5-year old broodstock giant clams obtained from MMDC, Palau were placed in unmarked sites within Apra Harbor between Sept. 20 and Oct 12, 1989 and the remainder left at the Fadian facility. Twelve clams were placed at each of six Apra Harbor sites, 6 each at 5 and 10 m depths, respectively (Fig. 1). Those left at the Fadian facility were moved to a tank with inadequate water flow without our knowledge and became moribund or died by early January. Fifteen of the 27 that were still alive were immediately placed in 10 m of water at the Glass Breakwater site. By late February, most or all of the clams at all the 5 m sites except Sasa Bay and possibly a few of those at the 10 m Glass Breakwater sites had been poached, so those remaining were moved to 10 m. By mid-June, all clams at the Glass Breakwater sites had been poached, leaving only those at the Sasa Bay and Jade Shoals Sites. The clams in the easternmost Sasa Bay site could not be checked in June due to adverse tides and recent rains that had rendered the water too turbid for a search to be made. This was the only site free of poaching in which all clams were alive and healthy in February. The relatively high turbidity apparently discourages diving activity as well as prevents the clams from being detected. It is therefore presumed that they are still there.

All clams still present were measured during February. Positive growth was noted for all clams and all appeared healthy and free of parasites or evidence of attempted predation (Table. 1). Growth of 34 clams ranged from 6 to 49 mm for the first 122 to 130 days since placement. Mean daily growth was similar for all sites and depths, ranging from 0.130 to 0.159 mm/day (47.5-58.0 mm/year) with an overall mean of 0.138 mm/day (50.4 mm/year).

Table 1. Growth rates of transplanted *Tridacna derasa* in mm/day (d). All clams at sites E and F were poached before they could be measured. Column headings are defined as follows: I = number (no.) of days in field; II = no. of clams (5m); III = mean daily growth (5m); IV = no. of clams (10m); and V = mean daily growth (10m).

SITES	I	II	III	IV	V
A	130	6	.132	6	.159
B*	130	-	-	6	.146
C	122	Poached	-	6	.130
D	122	2	.152	6	.137
All Sites	-	8	.137	24	.143

All Clams – 34 clams in total. Avg Growth Rate = 0.138 mm/d (50.4 mm/yr)
*4 out of 6 clams were poached. The remaining 2 clams were moved from 5m to 10m depth before remeasurement.

RECOMMENDATIONS

It is recommended that this project remain active as long as transplanted clams are still living. Since over half of the transplanted clams were poached, no new clams should be placed until a more suitable area for seeding is found or a marine preserve is established.

LITERATURE CITED

Copeland, J. W. and J. S. Lucas, eds. 1988. Giant clams in Asia and the Pacific. Australian Center for International Agricultural Research, Monograph 9, Canberra, 274 pp.

Heslinga, G. A., T. C. Watson, and T. Isamu. 1990. Giant Clam Farming. Pacific Fisheries Development Foundation (NMFS/NOAA), Honolulu, Hawaii, 179 p.

Report prepared by: Robert F. Myers

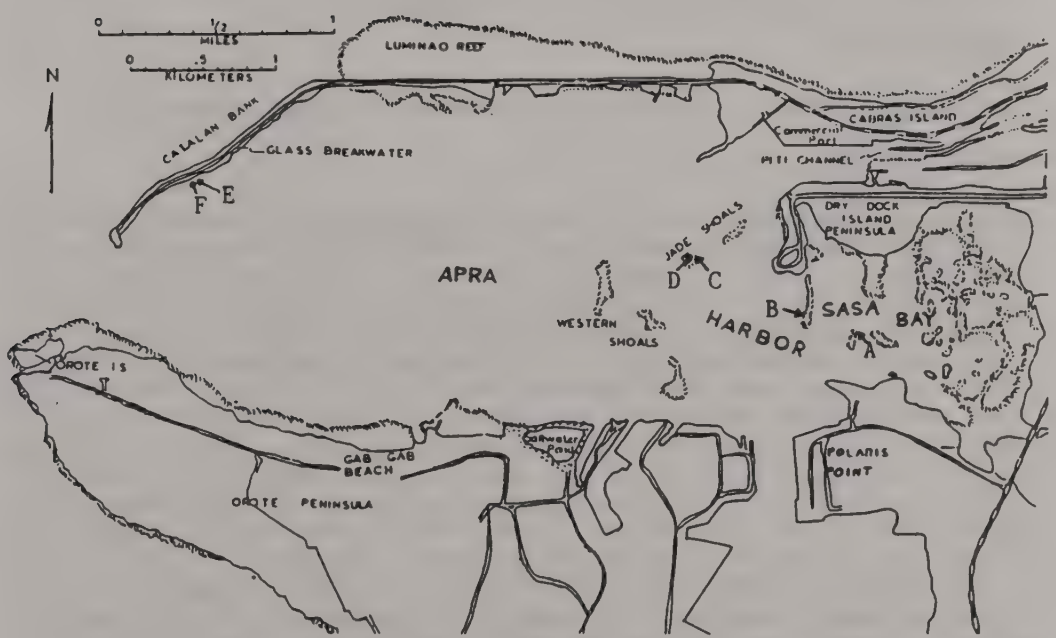


Figure 1. Map of Apra Harbor showing locations of transplanted *Tridacna derasa*. Twelve clams, 6 each at 5 and 10 meters respectively, were transplanted at each site.

COMMERCIAL FISHERIES

STATE: Territory of Guam

JOB TITLE: Commercial Fisheries on Guam

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

The commercial fisheries activity between January and June, 1990 came to a total of 56,690 kilograms and had a dollar value of $240,221.22. The trolling fish catch made up 86% of the total fish weight caught between January and June of FY90. Reef fish (5%), bottomfish (4%), imported fish (4%), other fish (1%) and some invertebrates made up a smaller portion of the catch.

BACKGROUND

The Commercial Fisheries Program has been established primarily to learn more about the fishery resource being caught and sold on Guam. In the past, the National Marine Fisheries Service (NMFS) has been collecting data only from the Guam Fishermen's Cooperative in Agana. Because it's been difficult for NMFS to handle the logistics of the program indirectly from the Hawaii, the DAWR has assisted directly with the program since January, 1990 and hopefully will be an on-going project.

OBJECTIVES

To determine the annual amount of commercial fisheries activity around Guam.

PROCEDURES

Initially, most of the vendors around Guam were contacted regarding commercial fisheries. We decided to concentrate our energy initially with the major fish vendors. The ones that were willing to initiate the program with us were The Safeway Markets, Guam Fishermen's Cooperative, and two roadside vendors. The Guam Commercial Fisheries receipt books were distributed to the vendors in January to initiate the program. The format for the receipts is indicated on Figure 1. Each receipt asks for information to be completed by each cooperating vendor while the catch is being purchased. On each receipt, there is a space provided for the name of the person providing the catch, fisherman number, date, number of fishermen, hours fished, fishing location and fishing method. The fishing location number and fishing methods code are determined by using the chart included on the inside of each receipt book cover as shown in Figure 2. The catch information is broken down into six primary areas: (1) Bottom fish, (2) Reef fish, (3) Troll fish, (4) Invertebrates, (5) Seaweeds, and (6) Imported Items. Each item has a code number to identify the fish, invertebrate, or seaweed. Space is provided to indicate the number of items, total weight, price per pound, the value of the items, the total value of the transaction and any additional remarks about the transaction. There are three copies of each form with one for the person representing the catch, one for the vendor, and one for processing the information into the computer data base.

Figure 1.

Guam Commercial Fisheries

(Use this form only when purchasing directly from fishermen) NO 61650

RECEIVING RECORD

RECEIVED FROM _____ FISHERMAN NO _____ DATE _____

_____ NUMBER OF FISHERMEN _____ HOURS FISHED _____

_____ FISHING LOCATIONS _____

FISHING METHOD _____

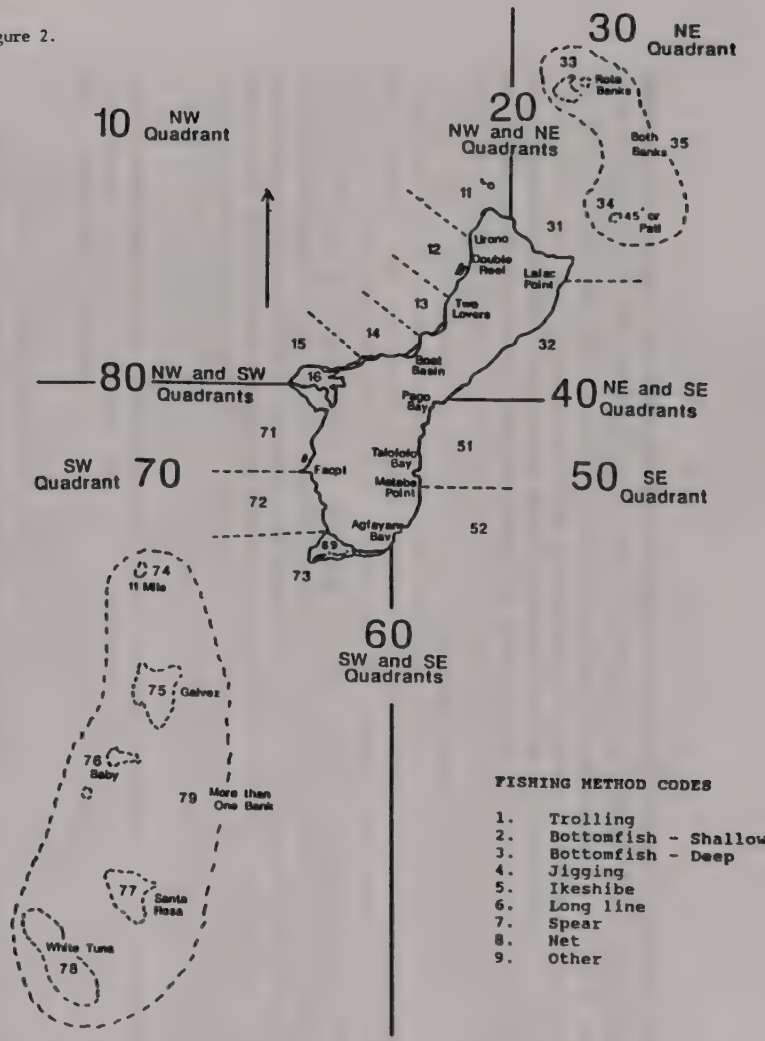
Fish Description	Fish Code	Number Pieces	Weight	Price Per Lb.	Extended Value
BOTTOM FISH	200				
Ehu	203				
Gindai	204				
Grouper	206				
Kalikali	207				
Lehi	208				
Onaga	210				
Opakapaka	212				
Uku	213				
Mafute	310				
Amberjack	106				
REEF FISH	300				
Hilting	304				
Sesyan	308				
Sukuk (Menpachi)	312				
Parrotfish	314				
Snapper	316				
Surgeon	318				
Unicorn	320				
Goatfish	322				
OTHER	100				
Atulai	102				
Crevally (Jacks)	104				
Sharks	150				
IMPORTED	700				

Fish Description	Fish Code	Number Pieces	Weight	Price Per Lb.	Extended Value
TROLL FISH	400				
Barracuda	402				
Mahimahi	404				
Mahimahi	404				
Marlin	406				
Sailfish	408				
Rainbow Runner	410				
Wahoo	412				
Wahoo	412				
Donuts (Tuna)	452				
Donuts (Tuna)	452				
White Tuna	454				
Yellowfin Tuna	456				
Yellowfin Tuna	456				
INVERTEBRATES	500				
Lobster	504				
Octopus	506				
Shrimp	508				
SEAWEEDS	600				
TOTAL POUNDS					

RECEIVING RECORD TOTAL

Remarks:

Figure 2.



The vendors have been visited on a regular basis to monitor their progress, data computation, receipt book completion, and double check the number of remaining receipt books. A logbook has been established for recording when a receipt book is initially given and received back from a vendor. When a receipt book is returned, the name of the vendor is indicated on the outside at the top to indicate what vendor completed the receipt book. The receipt books have been transmitted to the NMFS office at Hawaii for data processing. After the data input into the computers has been completed, they are returned to DAWR and distributed back to the respective vendors.

RESULTS

The commercial fisheries activity for the first six months reached a total of 56,690 kilograms and a dollar value of $240,221.22. The total commercial fisheries landings by species and dollar values for the first six months are presented in Table 1 and monthly data are presented in Tables 2 - 7. The trolling fish catch made up 86% of the total fish weight caught between January and June of FY 1990. Reef fish (5%), bottomfish (4%), imported fish (4%), other fish (1%) and some invertebrates made up a smaller portion of the catch.

Of the trolling catch, mahi-mahi made up 39% of the total catch. Marlin and wahoo along with skipjack and yellowfin tuna made up 17% and 12% of the catch, respectively. Barracuda, spearfish, sailfish, rainbow runner, dogtooth tuna, and kawa-kawa made up the remainder of the trolling catch. With the identified species of reef fish, goatfish (17%), parrotfish (17%), unicorn fish (14%), squirrelfish (10%), emperor fish (mafute) (10%), rabbitfish (Hitting) (10%), snapper (8%), rabbitfish (sesjan) (7%) and surgeonfish (7%) were caught. In the identified bottomfish catch, grouper (43%), onaga (20%), red snapper (12%), opakapaka (pink snapper) (8%), uku (Gray Snapper) (6%), lehi (silverjaw) (6%), Kalikali (pink snapper) (3%) and gindi (2%) were caught. Of the identified miscellaneous fish, jacks (54%), mullet (37%) and big-eye scad (atulai) (9%) were caught. In the invertebrate category, octopus (57%) and lobster (43%) made up the catch. Imported fish made up 4% of the total reported catch; although, it is probably much larger on an island wide basis. Commercial activity with seaweeds was not indicated on the receipts.

The major trolling fish [Dolphin (mahi-mahi), wahoo, marlin, skipjack and yellowfin tuna] made up about 83% of the total catch and the catch data showed some fluctuations during the six-month period. The mahi-mahi showed a large catch increase between January and February and a major decline between April and May. Wahoo increased to a peak in March and declined slowly in volume to June. Marlin showed a slight rise and decline between January and March. There was a sharp rise in the marlin catch between April and June. Both the yellowfin and skipjack tuna showed a rise in catch between January and March with the skipjack holding steady and declining between May and June. The yellowfin tuna showed a steady decline between March and June. Marlin and mahi-mahi showed a stronger relationship between prices and supply/demand than the other major trolling fish. Mahi-mahi, wahoo, and yellowfin tuna demand a higher market value than marlin and skipjack tuna.

DISCUSSION

In general, there has been some resistance by vendors in completing and use of the receipt books. Some vendors hesitate to complete the forms and participate in the program because they feel that the information is too confidential to be released and dislike the amount of time it takes to complete each receipt. Most vendors who are voluntarily cooperating with us fully have found the information in the yearly and monthly printouts to be beneficial and worth their time. Because of time pressure associated with making a transaction in buying fish, vendors often hesitate to fill out the receipts completely. A

common error made is that often they do not want to count out the number pieces of each item. Because data completion on the receipts at times can be inconsistent, certain types of data will be hard to analyze.

Most of the commercial fisheries data collected for the first six month period is included in this FY90 report; but, not all the data from the receipts was able to be inputted into the computers at the NMFS office in Hawaii. Our data does not include information from some of the major commercial fisheries operations at Merizo and Agat. Some of the Philippine or Micronesian vendors that sell imported and/or locally caught fish are not being covered. The monitoring of every imported fish to Guam is not the objective of our program. We are basically interested in monitoring the resource base around Guam. The imported fish in our data base is from vendors that we are presently working with that do some importing to supplement their locally caught fish. At this time, we are not monitoring the direct marketing of locally caught fish to hotels and restaurants. Some of our present vendors are handling some aspects of that market. There are numerous places around Guam where caught fish are sold spontaneously. They are fairly difficult to monitor and often have inshore fish in the catch. Because people who buy and sell fish are not required by law to report their transactions, it is difficult to monitor all aspects of the commercial fisheries around Guam at this time.

RECOMMENDATIONS

1. A computer program needs to be established for the Commercial Fisheries data that will be useable on our computers. This would allow the data to be analyzed locally instead of being shipped off-island to be processed.

2. A law or regulation needs to be passed, that would make it mandatory for vendors of local fish products to use our commercial fisheries reccipts in their business transactions. This would give us a more comprehensive view of the commercial fisheries activity around Guam. If such a law or regulation is passed, the person working directly with new vendors should be accompanied by a Conservation Officer until they complete the forms on a regular basis with no hesitation and/or resistance.

Report prepared by: Wayne Kruckenberg

le 1. GUAM 1990 YEAR-TO-DATE COMMERCIAL LANDINGS
FISH PURCHASES BY SPECIES
January through June

CIES NAME	WEIGHT	VALUE	$/LB
CELLANEOUS	62.50	130.00	2.08
EYE SCAD (ATULAI)	96.50	207.25	2.15
KS	564.50	1114.00	1.97
LET	388.00	818.00	2.11
TOM FISH	1839.00	4518.29	2.46
(RED SNAPPER)	303.00	962.50	3.18
DAI (FLOWER SNAP)	53.50	160.50	3.00
UPER	1117.00	2209.50	1.98
IKALI (PINK SNAP)	64.00	192.00	3.00
HI (SILVERJAW)	155.25	465.38	3.00
AGA (RED SNAPPER)	525.50	3219.00	6.13
AKAPAKA (PINK SNP)	214.50	653.25	3.05
(GRAY SNAPPER)	150.50	306.63	2.04
F FISH	1850.50	4477.36	2.42
ASSE	2.00	4.00	2.00
BBITFISH (HITTING)	437.00	1247.25	2.85
BBITFISH (SESJUN)	314.00	942.00	3.00
PEROR (MAFUTE)	470.00	1106.62	2.35
UIRRELFISH	444.00	1331.50	3.00
RROTFISH	766.50	2297.00	3.00
APPER	360.50	1038.75	2.88
RGEONFISH	299.00	897.00	3.00
ICORNFISH	634.00	1902.00	3.00
ATFISH	775.00	2294.00	2.96
OLL FISH	15.50	31.00	2.00
RRACUDA	1011.00	2014.27	1.99
LPHIN (MAHIMAHI)	42264.25	82022.38	1.94
RLIN	17898.90	18206.31	1.02
EARFISH	47.00	56.00	1.19
ILFISH	1011.50	1308.65	1.29
INBOW RUNNER	296.50	615.01	2.07
HOO	17764.40	39154.94	2.20
NAS	16.50	37.13	2.25
IPJACK TUNA	13355.00	16119.68	1.21
GTOOTH TUNA	1163.50	2381.82	2.05
LLOWFIN TUNA	12720.20	29592.62	2.33
WAKAWA	176.00	219.38	1.25
BSTER	113.75	568.75	5.00
TOPUS	150.50	518.75	3.45
PORTED	5110.00	14880.75	2.91
TOTAL **	125000.75	240221.22	1.92

NOTE: These are preliminary data and will change ***

e 3. GUAM FEBRUARY 1990 COMMERCIAL LANDINGS
FISH PURCHASES BY SPECIES

ECIES NAME	WEIGHT	VALUE	$/LB
CKS	7.00	14.00	2.00
OUPER	71.00	213.00	3.00
EF FISH	233.00	585.63	2.51
BBITFISH (HITTING)	212.00	636.00	3.00
BBITFISH (SESJUN)	201.00	603.00	3.00
UIRRELFISH	217.00	651.00	3.00
RROTFISH	369.00	1107.00	3.00
APPER	149.00	447.00	3.00
RGEONFISH	170.00	510.00	3.00
ICORNFISH	278.00	834.00	3.00
ATFISH	406.00	1218.00	3.00
RRACUDA	100.50	196.63	1.96
LPHIN (MAHIMAHI)	13081.25	26299.47	2.01
RLIN	2294.00	2975.13	1.30
AILFISH	69.00	114.50	1.66
AINBOW RUNNER	57.00	118.88	2.09
AHOO	2847.00	6527.60	2.29
KIPJACK TUNA	1783.00	2444.04	1.37
OGTOOTH TUNA	53.50	104.88	1.96
ELLOWFIN TUNA	2890.50	6959.52	2.41
OBSTER	59.75	298.75	5.00
CTOPUS	81.50	277.25	3.40
MPORTED	1693.00	5079.00	3.00
* SUBTOTAL **	27323.00	58214.28	

NOTE: These are preliminary data and will change ***

Table 2. GUAM JANUARY 1990 COMMERCIAL LANDINGS
FISH PURCHASES BY SPECIES

SPECIES NAME	WEIGHT	VALUE	$/LB
BIGEYE SCAD (ATULAI)	68.00	136.00	2.00
JACKS	119.00	238.00	2.00
BOTTOM FISH	158.50	397.88	2.51
GINDAI (FLOWER SNAP)	3.00	9.00	3.00
GROUPER	22.00	66.00	3.00
LEHI (SILVERJAW)	0.75	1.88	2.51
UKU (GRAY SNAPPER)	13.00	26.00	2.00
REEF FISH	54.50	132.35	2.43
RABBITFISH (HITTING)	22.00	66.00	3.00
RABBITFISH (SESJUN)	18.00	54.00	3.00
EMPEROR (MAFUTE)	18.00	50.00	2.78
SQUIRRELFISH	30.00	90.00	3.00
PARROTFISH	18.00	54.00	3.00
SNAPPER	26.00	78.00	3.00
SURGEONFISH	27.00	81.00	3.00
UNICORNFISH	41.00	123.00	3.00
GOATFISH	43.00	129.00	3.00
BARRACUDA	143.00	275.27	1.92
DOLPHIN (MAHIMAHI)	4127.00	8965.89	2.17
MARLIN	723.50	841.88	1.16
RAINBOW RUNNER	7.50	15.00	2.00
WAHOO	2542.00	5689.93	2.24
SKIPJACK TUNA	770.50	965.63	1.25
DOGTOOTH TUNA	403.00	912.06	2.26
YELLOWFIN TUNA	569.00	1347.51	2.37
KAWAKAWA	40.50	48.50	1.20
LOBSTER	3.00	15.00	5.00
OCTOPUS	2.00	7.00	3.50
IMPORTED	208.00	624.00	3.00
** SUBTOTAL **	10220.75	21439.78	

*** NOTE: These are preliminary data and will change ***

Table 4. GUAM MARCH 1990 COMMERCIAL LANDINGS
FISH PURCHASES BY SPECIES

SPECIES NAME	WEIGHT	VALUE	$/LB
JACKS	160.50	321.00	2.00
MULLET	109.50	261.00	2.38
BOTTOM FISH	81.00	181.40	2.24
EHU (RED SNAPPER)	4.00	12.00	3.00
GINDAI (FLOWER SNAP)	14.50	43.50	3.00
GROUPER	126.00	378.00	3.00
KALIKALI (PINK SNAP)	3.50	10.50	3.00
LEHI (SILVERJAW)	35.50	106.50	3.00
OPAKAPAKA (PINK SNP)	15.50	46.50	3.00
UKU (GRAY SNAPPER)	7.50	15.00	2.00
REEF FISH	56.50	153.25	2.71
RABBITFISH (HITTING)	152.00	456.00	3.00
RABBITFISH (SESJUN)	95.00	285.00	3.00
EMPEROR (MAFUTE)	193.00	456.50	2.37
SQUIRRELFISH	196.00	588.00	3.00
PARROTFISH	379.50	1136.00	2.99
SNAPPER	147.00	441.00	3.00
SURGEONFISH	102.00	306.00	3.00
UNICORNFISH	315.00	945.00	3.00
GOATFISH	294.00	882.00	3.00
BARRACUDA	172.50	335.50	1.94
DOLPHIN (MAHIMAHI)	12489.75	25441.86	2.04
MARLIN	588.00	799.62	1.36
SPEARFISH	18.00	27.00	1.50
SAILFISH	199.50	269.75	1.35
RAINBOW RUNNER	16.00	32.00	2.00
WAHOO	6491.75	14441.64	2.22
SKIPJACK TUNA	2847.50	3988.13	1.40
DOGTOOTH TUNA	237.50	442.88	1.86
YELLOWFIN TUNA	3272.30	7681.66	2.35
KAWAKAWA	58.00	87.00	1.50
LOBSTER	51.00	255.00	5.00
OCTOPUS	67.00	234.50	3.50
IMPORTED	2791.00	8341.75	2.99
** SUBTOTAL **	31787.30	69402.44	

*** NOTE: These are preliminary data and will change ***

Table 5. *GUAM APRIL 1990 COMMERCIAL LANDINGS FISH PURCHASES BY SPECIES*

SPECIES NAME	WEIGHT	VALUE	$/LB
MISCELLANEOUS	62.50	130.00	2.08
JACKS	214.00	409.50	1.91
MULLET	63.50	127.00	2.00
BOTTOM FISH	771.00	1924.00	2.50
EHU (RED SNAPPER)	42.50	127.50	3.00
GINDAI (FLOWER SNAP)	16.00	48.00	3.00
GROUPER	5.50	16.50	3.00
KALIKALI (PINK SNAP)	18.00	54.00	3.00
LEHI (SILVERJAW)	47.50	142.50	3.00
ONAGA (RED SNAPPER)	120.50	737.50	6.12
OPAKAPAKA (PINK SNP)	72.00	216.00	3.00
UKU (GRAY SNAPPER)	61.00	122.00	2.00
REEF FISH	579.00	1522.50	2.63
WRASSE	2.00	4.00	2.00
EMPEROR (MAFUTE)	127.50	318.75	2.50
SNAPPER	23.50	39.00	1.66
GOATFISH	2.00	5.00	2.50
TROLL FISH	15.50	31.00	2.00
BARRACUDA	347.00	719.37	2.07
DOLPHIN (MAHIMAHI)	11299.25	18745.87	1.66
MARLIN	1155.50	1434.00	1.24
SAILFISH	43.50	65.25	1.50
RAINBOW RUNNER	40.50	81.00	2.00
WAHOO	3816.00	7890.32	2.07
SKIPJACK TUNA	3112.00	3868.48	1.24
DOGTOOTH TUNA	265.00	585.75	2.21
YELLOWFIN TUNA	2665.00	6146.20	2.31
IMPORTED	418.00	836.00	2.00
** SUBTOTAL **	25405.25	46346.99	

*** NOTE: These are preliminary data and will change ***

Table 6. *GUAM MAY 1990 COMMERCIAL LANDINGS FISH PURCHASES BY SPECIES*

SPECIES NAME	WEIGHT	VALUE	$/L
JACKS	42.00	84.00	2.0
MULLET	15.00	30.00	2.0
BOTTOM FISH	280.50	674.88	2.4
EHU (RED SNAPPER)	89.50	280.25	3.1
GINDAI (FLOWER SNAP)	4.00	12.00	3.0
GROUPER	338.00	652.75	1.9
KALIKALI (PINK SNAP)	3.50	10.50	3.0
LEHI (SILVERJAW)	31.00	93.00	3.0
ONAGA (RED SNAPPER)	286.50	1823.00	6.3
OPAKAPAKA (PINK SNP)	45.50	146.25	3.2
UKU (GRAY SNAPPER)	18.50	37.00	2.0
REEF FISH	628.00	1369.75	2.1
RABBITFISH (HITTING)	51.00	89.25	1.7
EMPEROR (MAFUTE)	127.00	270.12	2.1
BARRACUDA	187.00	365.50	1.9
DOLPHIN (MAHIMAHI)	965.00	1920.15	1.9
MARLIN	5627.40	6188.55	1.1
SPEARFISH	29.00	29.00	1.0
SAILFISH	699.50	859.15	1.2
RAINBOW RUNNER	39.00	81.25	2.0
WAHOO	1553.40	3444.86	2.2
TUNAS	16.50	37.13	2.2
SKIPJACK TUNA	3066.00	3022.51	0.9
DOGTOOTH TUNA	78.00	91.75	1.1
YELLOWFIN TUNA	1961.90	4360.83	2.2
KAWAKAWA	25.50	31.88	1.2
** SUBTOTAL **	16208.20	26005.31	

*** NOTE: These are preliminary data and will change

Table 7. *GUAM JUNE 1990 COMMERCIAL LANDINGS FISH PURCHASES BY SPECIES*

SPECIES NAME	WEIGHT	VALUE	$/LB
BIGEYE SCAD (ATULAI)	28.50	71.25	2.50
JACKS	22.00	47.50	2.16
MULLET	200.00	400.00	2.00
BOTTOM FISH	548.00	1340.13	2.45
EHU (RED SNAPPER)	167.00	542.75	3.25
GINDAI (FLOWER SNAP)	16.00	48.00	3.00
GROUPER	554.50	883.25	1.59
KALIKALI (PINK SNAP)	39.00	117.00	3.00
LEHI (SILVERJAW)	40.50	121.50	3.00
ONAGA (RED SNAPPER)	118.50	658.50	5.56
OPAKAPAKA (PINK SNP)	81.50	244.50	3.00
UKU (GRAY SNAPPER)	50.50	106.63	2.11
REEF FISH	299.50	713.88	2.38
EMPEROR (MAFUTE)	4.50	11.25	2.50
SQUIRRELFISH	1.00	2.50	2.50
SNAPPER	15.00	33.75	2.25
GOATFISH	30.00	60.00	2.00
BARRACUDA	61.00	122.00	2.00
DOLPHIN (MAHIMAHI)	302.00	649.14	2.15
MARLIN	7510.50	5967.13	0.79
RAINBOW RUNNER	136.50	286.88	2.10
WAHOO	514.25	1160.59	2.26
SKIPJACK TUNA	1776.00	1830.89	1.03
DOGTOOTH TUNA	126.50	244.50	1.93
YELLOWFIN TUNA	1361.50	3096.90	2.27
KAWAKAWA	52.00	52.00	1.00
** SUBTOTAL **	14056.25	18812.42	
** 1990 Year-to-date:	125000.75	240221.22	

*** NOTE: These are preliminary data and will change ***

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

Participation in recreational hunting increased 15% during FY90 with a total of 648 licenses sold during the fiscal year. Deer hunting remained a popular past time and an estimated 196 hunters spent 1597 days hunting and reported harvesting 23 deer. The military bases on the northern end of the island were reported as the preferred areas to hunt deer. Andersen Air Force Base and NAVCAMS accounted for 40% and 22%, respectively, of the reported hunting effort. Bolanos and Cotal (Tarzan Falls) Territorial Conservation Reserves and private property received 2%, 9%, and 7%, respectively, of the reported effort. Population trend data obtained with spotlight counts indicated no significant change ($p > 0.05$) in deer numbers at AAFB or at Naval Magazine.

BACKGROUND

The Guam deer (*Cervus unicolor*) has been under investigation by the Division of Aquatic & Wildlife Resources since 1961. Its distribution, population trends, and biology have been described by Wheeler (1979). Deer hunting statistics have been compiled since 1968 through hunter reporting procedures. The regular deer season is October 1 through December 31 with a bag limit of one antlered deer (buck only) per season per license holder exclusive of any special hunt harvest. During FY90, the hunting regulation was revised to add the month of September as an additional month to hunt for deer during the regular season. The Director of Agriculture can authorize a special either-sex hunt to thin a particular herd in situations where the population possesses a threat to life and property and to prevent damage to other natural resources from over grazing.

OBJECTIVES

To determine the current size and distribution of the deer population of Guam and to monitor population trends.

PROCEDURES

1. Continue spotlight counts on AAFB at 21 counts per year with 4 per month during May - July and one per month in other months.

    a. Record number, age, sex and group composition.

b. Statistically analyze count data and compare with past data to discern population trends.

2. Continue monthly spotlight counts on Naval Magazine with periodic spotlight counts in other areas.

3. Collect hunting statistics via a hunter questionnaire. Analyze hunting statistics for changes in hunter kills, effort, and hunting location.

4. Collect biological data from carcasses killed during regular season and special hunts or from incidental sources such as road kills or confiscated animals.

RESULTS

Deer Hunting Statistics

License sales increased 15% during FY90 with 648 sold during the year. Only 450 license holders were mailed a harvest questionnaire and responses were obtained from 104 persons (23%). Outdated or incomplete mailing addresses continues to be a problem and 6% of the mailed questionnaires were returned as undeliverable. Of the 104 persons responding to the questionnaire, 65% indicated they had hunted at some time during the October 1 - September 31, license year. Based on that percentage, an estimated 424 people legally hunted game during the past year.

Forty-six percent of those that reported hunting during FY90 hunted during the regular deer season (Table 1). This represented a change from the participation reported last year. Hunter success, however, increased to 21% from the 13% reported in FY89. Of the 10 deer that were reported as harvested in the questionnaire, three came from Northwest Field, 1 from AAFB, 1 from NCS, and 1 from Yigo, and four from southern areas of Agat, Bolanos Conservation Reserve, Cotal (Tarzan Falls) and Nimitz Hill. Six of these deer were taken by shotgun and 4 by rifle. Deer hunters spent an average of 8 hunter days pursuing deer.

Table 1. Island-wide deer hunting statistics for FY90 based on hunter responses to a harvest questionnaire.

a.	Total license sales for all game species	648
b.	Number of questionnaires sent out	450
c.	Number of hunter questionnaires returned	104
d.	Percent of queried license buyers that responded	23%
e.	Number of reporting license buyers (104) that hunted any species	68
f.	Percent of license buyers that hunted deer	65%
g.	Estimated total number of legal hunters	424
h.	Number of reporting hunters (104) that hunted deer during the regular season	48
i.	Percent of reporting hunters that hunted deer during the regular season	46%
j.	Number of deer taken by 48 deer hunters	10
k.	Hunter success	21%
l.	Hunter-days expended by 48 reporting deer hunters	392
m.	Average number of days spent per reporting deer hunter	8
n.	Estimated total number of legal deer hunters	196
o.	Estimated total legal deer take	23
p.	Estimated total number of days spent hunting deer	1597
q.	Number of days spent hunting per deer taken	70

Estimates of total hunter participation, effort, and harvest were derived from the questionnaires. Based on these data, an estimated 196 hunters spent 1597 days hunting and harvested 23 deer, a 43% decrease in participation, 49% decrease in harvest, and a 61% decrease in effort over FY89 levels. Deer hunters expended an average of 70 hunter-days of effort per deer harvested, a decrease from the 91 days/deer expended in FY89.

The military bases on the northern end of the island remained the preferred areas to hunt deer. Andersen Air Force Base and NAVCAMS accounted for 40% and 22%, respectively, of the reported hunting effort of 392 hunter-days. Bolanos and Cotal (Tarzan Falls) Territorial Conservation Reserves received 2% and 9%, respectively, of the reported effort and private property received 7% of the reported effort.

The shotgun remained the most heavily used weapon for deer hunting being used for 71% of the reported hunting effort. Rifles and bow were less popular and used for 13% and 12%, respectively, of the hunting effort. The pistol was used only 5%.

A record of hunting activity and harvest is kept at NAVCAMS and Andersen Air Force Base during the regular season (Table 2). According to logs, 1022 hunter-sorties were expended on NAVCAMS and resulted in the harvest of 14 deer. This harvest was an increase of 2.5 times over FY89.

Table 2. Hunter effort and deer take based on official hunter logs from Naval Communication Area Master Station (NAVCAMS), Northwest Field, and on Andersen Air Force Base during FY90.

	Oct	Nov	Dec	Sep-90	Total
NAVCAMS					
No. hunter-sorties	378	207	315	122	1022
No. hunter-days (8-hr)					
Deer taken	2	1	8	3	14
Days effort/take	-	-	-		-
Anderson Air Force Base					
Northwest Field					
No. hunter-sorties	–	–	–	232	232
No. hunter-days (8-hr)	–	–	–	144	144
Deer taken	–	–	–	7	7
Days effort/take	–	–	–	20.5	20.5
Other Base Hunting Areas					
No. hunter-sorties	–	–		123	123
No. hunter-days (8-hr)	–	–		60	60
Deer taken	–	–		1	1
Days effort/take	–	–		60.1	60.1
Totals Andersen Air Force Base					
No. hunter-sorties	–	–	–	355	355
No. hunter-days (8-hr)	–	–	–	204	204
Deer taken	–	–	–	8	5
Days effort/take	–	–	–	25.5	25.5

Hunting was closed on Andersen Air Force Base on February 1, 1989 due to a hunting accident. The base was reopened to hunting in April 1990. Data provided for AAFB is therefore only for September, which is a new additional month to hunt deer during the regular season. According to logs, 144 hunter-days (232 hunter-sorties) were expended in NWF and resulted in the harvest of 7 deer. In other designated hunting areas on AAFB, 60 hunter-days (125 hunter-sorties) were expended which resulted in the harvest of only 1 deer.

Spotlight Count Trends

Deer numbers remained high on AAFB during FY90 (Table 3). Numbers observed during the best 3 months of the year for sighting deer, May-July, were not significantly different

from those observed during FY88 (Mann-Whitney U-Test, U = 76.5, n_1=12, n_2=12, p > 0.05, Sokal and Rohlf 1981). The average number of deer seen per count increased slightly (7%) from 128.3 during May-July, 1989 to 138.8 during May-July, 1990. Likewise, numbers observed throughout the entire year did not vary statistically from those recorded the previous year (Mann-Whitney U-Test, U = 85, n_1=12, n_2=12, p > 0.05). The average number of deer seen per count (October-September) increased slightly (7%) from 116.8 in FY89 to 125.1 in FY90. The largest single nightly count increased from 249 deer per 10 km in FY89 to 251 deer per 10 km in FY90.

Deer numbers observed on Naval Magazine decreased during FY90. However, numbers observed on deer counts were not significantly lower (Mann Whitney U-Test, U=84.5, n_1=12, n_2=12, p > 0.05) than those observed the previous year. The average number of deer seen per count decreased 15% from 33.1 deer in FY89 to 28.0 deer in FY90 (Table 4).

RECOMMENDATION

1. Continue spotlight counts at present intensity at NAVMAG and AAFB. Collect biological data from carcasses as available.

2. Continue to collect hunting statistics from hunter questionnaire.

3. Implement special control hunts as necessary to control deer populations in selected areas.

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Report prepared by: Celestino F. Aguon

Table 3. Composition of deer herd seen during spotlight counts at Andersen Air Force Base, FY90.

	COUNT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAR	JUNE	JULY	AUG	SEP	TOTAL	AVG	SD	CV-%
UNCLASSED	1	4	3	3	0	3	5	3	2	2	0	1	1	51	2.4	2.4	97
BUCK	2								1	1	3						
	3								11	0	2						
	4								2	2	2						
	5								3								
	AVG	4.0	3.0	3.0	0.0	3.0	5.0	3.0	3.8	1.3	1.8	1.0	1.0				
SPIKE	1	1	2	4	3	1	3	3	2	2	2	2	3	50	2.4	1.2	49
	2								3	3	1						
	3								1	3	3						
	4								5	3	0						
	5								1								
	AVG	1.0	2.0	4.0	3.0	1.0	3.0	3.0	2.4	2.8	1.5	2.0	3.0				
TWO-POINT	1	0	3	1	1	1	4	2	2	1	4	2	1	50	2.4	1.6	68
	2								3	3	1						
	3								5	6	1						
	4								4	4	1						
	5								2								
	AVG	0.0	3.0	1.0	1.0	1.0	4.0	2.0	3.2	3.5	1.8	2.0	1.0				
THREE-POINT	1	1	6	5	3	2	7	4	11	3	1	5	3	80	3.8	2.6	68
	2								3	8	2						
	3								1	4	2						
	4								3	5	1						
	5								6								
	AVG	1.0	6.0	5.0	3.0	2.0	7.0	4.0	4.8	5.0	1.5	5.0	3.0				
FOUR-POINT	1	0	0	0	1	1	1	1	2	0	2	3	2	21	1.0	1.1	110
	2								0	0	4						
	3								1	1	0						
	4								0	1	1						
	5								0								
	AVG	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.6	0.5	1.8	3.0	2.0				
DOE	1	44	80	44	40	38	57	61	89	62	47	58	42	1267	60.3	14.6	24
	2								61	81	64						
	3								77	67	52						
	4								68	74	61						
	5								32								
	AVG	44.0	80.0	44.0	40.0	38.0	57.0	61.0	65.4	71.0	56.0	58.0	42.0				
YEARLING	1	9	8	6	7	4	2	8	9	4	4	4	3	127	6.0	2.8	47
	2								5	5	5						
	3								14	7	4						
	4								4	10	5						
	5								8								
	AVG	9.0	8.0	6.0	7.0	4.0	2.0	8.0	8.0	6.5	4.5	4.0	3.0				
FAWN	1	4	6	4	2	2	6	7	2	2	1	7	2	78	3.7	2.0	53
	2								5	6	1						
	3								3	4	2						
	4								3	6	3						
	5								3								
	AVG	4.0	6.0	4.0	2.0	2.0	6.0	7.0	3.2	4.5	1.8	7.0	2.0				
UNCLASSED	1	36	39	26	36	49	56	63	44	31	43	29	27	928	44.2	10.9	25
DEER	2								45	49	55						
	3								46	56	54						
	4								43	61	40						
	5								45								
	AVG	36.0	39.0	26.0	36.0	49.0	56.0	63.0	44.6	49.3	48.0	29.0	27.0				
TOTAL	1	99	147	93	93	101	141	152	163	107	104	111	84	2652	126.3	25.9	21
	2								126	156	136						
	3								159	148	120						
	4								132	166	114						
	5								100								
	AVG	99.0	147.0	93.0	93.0	101.0	141.0	152.0	136.0	144.3	118.5	111.0	84.0				
MILES	1								4.6	4.0	4.6	4.6	4.6				
TRAVELED	2								4.6	4.0	4.1						
	3								4.8	4.6	4.1						
	4								4.6	4.0	4.7						
	5								4.0								
MILES (AVG)		4.4	3.9	5.3	5.3	4.6	4.0	4.6	4.5	4.2	4.4	4.6	4.6				
KM (AVG)		7.0	6.2	8.5	8.5	7.4	6.4	7.4	7.2	6.6	7.0	7.4	7.4				
DEER/10Mi		225.0	376.9	175.5	175.5	219.6	352.5	330.4	300.9	347.6	270.9	241.3	182.6		266.6	73.6	28
DEER/10Km		140.6	235.6	109.7	109.7	137.2	220.3	206.5	6.4	217.2	169.3	150.8	114.1		151.5	64.5	43
BUCKS	1	2	2	2	0	1	2	1	2	1	0	2	2	30	1.4	0.8	57
(in velvet)	2								1	1	3						
	3								2	1	0						
	4								2	1	2						
	5								0								
	AVG	2.0	2.0	2.0	0.0	1.0	2.0	1.0	1.4	1.0	1.3	2.0	2.0				

Table 4. Composition of deer herd and number of water buffalo seen during spotlight counts at Naval Magazine in FY90.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	TOTAL	AVE.	SD	CV (%)
UNCLASSED BUCK	0	3	1	1	1	2	5	2	0	0	1	5	21	1.8	1.76	101
SPIKE	1	1	0	0	2	1	0	1	2	1	2	0	11	0.9	0.79	87
TWO-POINT	1	0	0	1	2	1	1	2	0	1	0	1	10	0.8	0.72	86
THREE-POINT	1	1	2	1	2	0	1	0	3	3	0	3	17	1.4	1.16	82
FOUR-POINT	0	1	0	0	0	0	0	0	0	0	0	0	1			
DOE	11	12	7	9	14	15	8	10	5	10	7	14	122	10.2	3.16	31
YEARLING	1	1	4	3	2	2	2	0	1	0	1	1	18	1.5	1.17	78
FAWN	1	2	3	2	0	1	0	2	2	3	2	2	20	1.7	0.98	59
UNCLASSED DEER	9	14	14	15	6	7	7	9	10	7	5	13	116	9.7	3.50	36
TOTAL	25	35	31	32	29	29	24	26	23	25	18	39	336	28.0	5.72	20
MILES TRAVELED	14.9	14	14.9	14.9	15.9	15	15	16.5	14.2	15.1	15.7	15	181.1	15.1		
Km TRAVELED	24.0	22.5	24.0	24.0	25.6	24.1	24.1	26.6	22.9	24.3	25.3	24.1	291.4	24.3		
DEER/10 Mi	16.8	25.0	20.8	21.5	18.2	19.3	16.0	15.8	16.2	16.6	11.5	26.0	223.6	18.6	4.14	22
DEER/10 Km	10.4	15.5	12.9	13.3	11.3	12.0	9.9	9.8	10.1	10.3	7.1	16.2	138.9	11.6	2.57	22
WATER BUFFALO	37	71	61	49	66	29	41	27	50	18	16	50	515.0	42.9	18.13	42
BUFFALO/10 Mi	24.8	50.7	40.9	32.9	41.5	19.3	27.3	16.4	35.2	11.9	10.2	33.3	344.6	28.7	12.65	44
BUFFALO/10 Km	15.4	31.5	25.4	20.4	25.8	12.0	17.0	10.2	21.9	7.4	6.3	20.7	214.1	17.8	7.86	44

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 2

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

The levels of interest in pig hunting increased while the harvest of pigs declined during FY90 from levels reported during the previous year. An estimated 462 pig hunters spent 5,203 hunter-days and harvested an estimated 1,122 pigs, an increase of 5% in hunter participation. Hunter-effort and harvest decreased 24% and 29% from FY89 levels. Hunter success increased from 60% in FY89 to 72% this year, but the average take per successful hunter decreased from 6.8 to 2.8 pigs. The effort expended per pig harvested increased slightly from 4.32 days/pig in FY89 to 4.62 days/pig in FY90. Northwest Field, private areas and Naval Communications Area Master Station (NAVCAMS) were identified as the more important pig hunting areas on Guam accounting for 38%, 34%, and 22% of the effort expended during the year. Anao, Bolanos, and Cotal (Tarzan Falls) Territorial Conservation Reserves were also reported as hunted. Official logs recording harvest statistics for AAFB indicated Northwest Field recorded a hunting effort of 647 hunter-sorties comprising 330 hunter-days with a harvest of 100 pigs and an effort/harvest of 3.3 days per pig. NAVCAMS documented harvest statistics of 1,601 hunter-sorties and a harvest of 79 pigs.

BACKGROUND

The wild pig *(Sus scrofa)* has long been an important natural resource on Guam and accounts for the greatest annual hunter recreation and harvest of all game animals. This species has been under investigation by the Division of Aquatic and Wildlife Resources since 1967 and the results of those and more recent studies have been summarized in a Division technical report (Conry 1988). The wild pig on Guam is a descendant of domestic *Sus scrofa* introduced by the Spanish from the Philippines between 1672 and 1685. Wild pigs are found island-wide but appear to be most numerous in the limestone forests of the north and the ravine forests of southern Guam. Pigs occur at high enough densities that rooting and wallowing damage are common in most forested areas and can be quite severe locally. Depredation on agricultural crops is also a problem, particularly so for farmers in southern Guam during the dry season. Controlling the effects of pig damage is recognized as an important measure to protect native forest and agricultural resources. Recreational harvest is the primary tool used to control pig numbers and current hunting regulations provide for a year-round season with bags limits of 2 pigs per day and 40 per year. There is a need to consider more liberal regulations to control pig populations island-wide and in localized areas.

OBJECTIVES

To monitor trends in pig population size and hunter participation and harvest.

PROCEDURES

1. Record pig sightings during deer spotlight counts, and observations of pigs or pig sign during other fieldwork.
2. Monitor hunter participation and harvest during the legal hunting season.

RESULTS

License sales increased 15% during FY90 with 648 sold during the year. Only 450 license holders were mailed a harvest questionnaire and responses were obtained from 104 persons (23%). Outdated or incomplete mailing addresses continues to be a problem and 6% of the mailed questionnaires were returned as undeliverable. Of the 104 persons responding to the questionnaire, 65% indicated they had hunted at some time during the October 1 - September 31 license year. Based on that percentage, an estimated 424 people legally hunted game during the past year.

Hunter participation in pig hunting remained high during FY90, 96% of the responding hunters indicated they had hunted pigs during the FY90 season (Table 1). The percentage of hunters succeeding in harvesting at least one pig during the year-long season increased from the 60% reported the previous year to 72% this year. The average take per hunter also decreased this past year from 4.1 pigs in FY89 to 2.8 in FY90. In addition, the average take per successful hunter decreased from 6.8 pigs in FY89 to 3.8 this year. Pig hunters spent less time in the field this year than last, an average of 13 days per hunter in FY90, a considerable decline from the 18-day average in FY89. Effort to harvest a pig this year increased slightly with 4.62 days/pig in FY90 versus 4.32 days/pig in FY89.

Table 1. Pig hunting statistics for FY89 compiled from a harvest questionnaire.

a.	Total license sales for all game species	648
b.	Number of questionnaires sent out	450
c.	Number of questionnaires returned	104
d.	Percent of queried license buyers that responded	23%
e.	Number of reporting license buyers (104) that hunted any species	68
f.	Percent of license buyers that hunted	65%
g.	Estimated total number of legal hunters	424
h.	Number of reporting hunters (68) that hunted pigs	65
i.	Percent of reporting hunters that hunted pigs	96%
j.	Number of successful pig hunters	47
k.	Hunter success	72%
l.	Number of pigs taken by the 47 successful pig hunters	180
m.	Average number of pigs taken per pig hunter	2.8
n.	Average number of pigs taken per successful hunter	3.8
o.	Number of hunter days expended by 68 reporting pig hunters	835
p.	Average number of days spent per reporting pig hunter	13
q.	Estimated total number of legal pig hunters	405
r.	Estimated total legal pig take	1122
s.	Estimated total number of days spent hunting pigs	5203
t.	Days of hunting effort per pig taken	4.64

Estimates of hunter participation, effort, and harvest derived from hunter questionnaires revealed an increase in participation, but a decrease in effort and harvest from the previous year. An estimated 405 hunters spent 5,203 days and harvested 1,122 pigs in FY90. Whereas in FY89, 387 pig hunters spent 6,850 days hunting pigs and harvested 1,586 pigs. Hunter participation increased 5%, hunter effort decreased 24%, and harvest decreased 29%.

The estimated total hunter participation, effort, and harvest seem far higher than actual activity and are likely over-estimates of effort and take. These results reflect the bias typical of hunter questionnaires where successful hunters are far more likely to report their activities than unsuccessful ones. Consequently, information derived from this questionnaire is more useful as an index of hunter activity than as an absolute estimate of total hunting effort.

The shotgun remained the most heavily used weapon for pig hunting and was used during 70% of the reported effort and accounted for 92% of the harvest. Bow hunting was next in popularity being used in 16% of the effort and accounting for 6% of the harvest. Handgun and rifle hunting were used for 11% and 3% of the effort respectively, and each accounted for 6% of the harvest.

Based on hunter questionnaires, Northwest Field and private areas received the greatest amount of hunting effort. Northwest Field and private areas received 38% and 34%, respectively, of the reported hunting effort and accounted for 26% and 42%, respectively, of the harvest. NAVCAMS received 22% of the effort and accounted for 14% of the harvest. Anao, Bolanos, and Cotal (Tarzan Falls) Territorial Conservation reserves received 2%, 1%, and 3%, respectively, of the hunting effort and accounted for 6%, 4%, and 8%, respectively, of the harvest.

A record of hunting activity and harvest was kept at NAVCAMS and Andersen Air Force Base (Table 2). Data for AAFB are only for April to September 1990. The base was reopened to hunting in April after a fatal hunting accident had occurred on AAFB during the February 1989 special hunt. This incident resulted in the cessation of the hunting program for all areas of the base during the remainder of FY89. This closure dramatically reduced the amount of pig hunting that occurred on AAFB during that year.

Based on hunter logs, Northwest Field recorded 330 hunter-days (647 hunter-sorties) and resulted in the harvest of 100 pigs (Table 2).

Table 2. Hunter effort and pig take based on official logs from Naval Communications Area Master Station (NAVCAMS), Anderson Airforce Base (AAFB), AAFB Northwest Field (NWF), and other AAFB Hunting Areas (HAs).

	MONTHS												
	O	N	D	J	F	M	A	M	J	J	A	S	**Totals**
NAVCAMS													
No. hunter sorties	378	207	315	65	69	73	97	62	71	98	44	122	1601
No. hunter days (8-hr)													
Pigs taken	9	6	14	5	9	7	5	4	3	8	5	4	79
Days Effort/Take													
AAFB NWF													
No. hunter sorties							102	122	92	44	55	232	647
No. hunter days (8-hr)							47	58	39	20	22	144	330
Pigs taken							24	17	20	10	13	16	100
Days Effort/Take							2	3.4	1.9	2	1.7	9	3.3
AAFB HAs													
No. hunter sorties							115	38	37	51	42	123	123
No. hunter days (8-hr)							40	12	12	17	13	60	60
Pigs taken							8	0	4	6	5	9	9
Days effort/take							4.9	0	3.1	2.8	2.7	6.7	6.7

Note: No hunting occurred on AAFB from October to March.

Because of the complete lack of hunting during this same period, no comparison could be made to the previous fiscal year. However, 100 pigs taken during FY90 is a 156% increase as compared to the same period in FY88 when only 39 pigs were taken (DAWR 1988).

The record of hunting activity from NAVCAMS indicated that 1601 hunter-sorties were expended on NAVCAMS and resulted in the harvest of 79 pigs. This is a 34% reduction in harvest compared to FY89 of 119 pigs.

RECOMMENDATIONS

Continue to monitor the annual pig harvest and hunter participation. Coordinate accurate record keeping and reporting of hunter effort and harvest at military bases.

LITERATURE CITED

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Report prepared by: Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Population Numbers and Distribution of Philippine Turtle-Doves.

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

The population of Philippine Turtle-Doves (*Streptopelia bitorquata*) may be on a downward swing as spring game bird surveys conducted this year showed a general decreasing trend over last year's count. Station counts at Northwest Field (NWF) had a significant decrease in numbers ($p < 0.05$) while the Conventional Weapons Area (CWA) on Andersen Air Force Base showed no significant change ($p > 0.05$) in numbers from the previous year. An average of 29.6 doves were recorded per count at NWF, down 14% from FY89 levels. Roadside counts in the CWA showed a slight decrease with average of 30.2 doves recorded per count, down 8% from FY89 levels. Turtle-Doves remain distributed through most of the island and were observed on 20 of the 22 spring game bird surveys conducted during May and June 1990. The number of doves observed per station increased on 7 routes, remained the same on 2 routes, and decreased on 13 routes. The pattern of change was statistically significant ($p < 0.05$) and was evident in the data. Doves were found in high numbers (≥ 1.0 birds/station) on the Cocos Island, Navy Golf Course in Barrigada, CWA, NWF, Orote Point, NAVCAMS, Reserve Craft Beach Road, and Mt. Santa Rosa.

BACKGROUND

The Philippine Turtle-Dove (*Streptopelia bitorquata*) was introduced to Guam by the Spanish during their early colonization of the region, circa 1771 (Baker 1951) and has been regulated as a game bird since as early as 1903 (Conry 1987). Up through the early 1960s, the turtle-dove was very common and found in large numbers in both northern and southern Guam. By the late 1960s, dove populations in southern and central Guam began to decline and have since stabilized at low levels. Populations in northern Guam declined in the late 1970s and early 1980s. Turtle-Doves are now found in appreciable numbers in prime dove habitat on NWF, CWA and elsewhere on Andersen Air Force Base and at moderate numbers in selected areas of central and southern Guam. A large population still remains on snake-free Cocos Island. Predation by the brown tree snake (*Boiga irregularis*) is the major cause of nest loss (Conry 1988) and this introduced pest is thought to be responsible for the population decline. Because of the decline in numbers and the extremely poor nesting success, the Department of Agriculture officially closed the turtle-dove hunting season as of March 28, 1987. The season will be reopened if nesting success improves and numbers recover to a level that can support recreational hunting.

OBJECTIVES

1. To determine present population levels and distribution, and monitor population trends.

PROCEDURES

Call-count and roadside-count surveys were conducted at NWF and the CWA on Andersen Air Force Base. Both surveys were conducted once to twice monthly in early morning. The call-count survey consisted of counting the number and species of doves seen or heard during a 5-minute period at 10 stations in NWF plus the number of doves seen enroute between stations. The roadside-count survey at CWA involved counting the number of Philippine Turtle-Doves seen while driving at 25 km per hour along an established 32 km route. The Philippine Turtle-Dove is also included in a twice monthly roadside-count of all birds conducted by DAWR Staff in 3 areas of northern Guam. The results of these surveys are reported in Job W-1-3.

Philippine Turtle-Doves were additionally surveyed during spring game bird counts conducted on 23 routes throughout the island in June. These surveys consisted of 5-minute station counts at up to 10 stations per route with the number of birds seen or heard recorded at each station. Results are summarized as the average number of birds observed per station.

RESULTS

Population Surveys

Call count surveys and roadside counts were continued at NWF and the CWA on Andersen Air Force Base (Table 1). Surveys on NWF showed a significant decrease over the previous year (Mann Whitney U-Test, $n_1 = 20$, $n_2 = 21$, $U = 300$, $p<0.05$, Sokal and Rolf 1981). The average count decreased (14%) from 34.3 birds/survey in FY89 to 29.6 birds/survey in FY90. This is change from the trend from that of FY89 which had recorded a significant increase in number of doves since these counts were started in 1983.

Table 1. Results of Philippine Turtle-Dove surveys at Northwest Field (NWF) and the Conventional Weapons Area (CWA) on Andersen Air Force Base, Guam during FY90.

	NWF Surveys			CWA Surveys		
Month	1	2	Average	1	2	Average
1988						
October	32	29	30.5	36	28	32
November	40	34	37.0	39	38	38.5
December	30	34	32.0	31	28	29.5
1989						
January	34	36	37.0	25		25.0
February	34	27	30.5	24	30	27.0
March	26		26.0	29	24	26.5
April	32	28	30.0	38	35	36.5
May	33		33.0	31	34	32.5
June	24		24.0	28		28.0
July	16	25	20.5	25	28	26.5
August	34		34.0	37	30	33.5
September	31	15	23.0	25	29	27.0
Survey Average			29.6			30.2

Roadside counts in the CWA exhibited a different trend and showed no significant change over previous years counts (Mann Whitney U-Test, $n_1 = 23$, $n_2 = 22$, $U = 300.5$, $p > 0.05$). The average count per survey decreased slightly (8%) from 32.7 birds/count in FY89 to 30.2 birds/count in FY90. This indicates the population in CWA has remained

stable since a significant increase was record last year which was the first significant increase in numbers that has occurred since these counts were started in 1983.

Spring Game Bird Surveys

Turtle-doves were recorded on 20 of the 22 spring game bird surveys conducted during 1990 (Table 2). Snake free Cocos Island continues to have the highest count on the island with an average of 4.4 birds observed per station. The Reserve Craft Beach route had the next highest count with 3.75 birds/station recorded there. The CWA, NWF, Navy Golf Course, Orote Point, Tarague, and Mt. Santa Rosa routes also had station counts ≥ 1.0 birds/station. The largest increases in numbers occurred on Reserve Craft Beach survey where the average station count increased 3.5 birds/station. There appears to be a decreasing trend in population for the southern part of the island. Numbers increased on 7 routes, remained the same on 2 routes, and decreased on 13 routes. This pattern of change was significantly different from random variation (Wilcoxon Signed-rank Test, $Z = -0.85$, $p < 0.05$) indicating there was an island-wide decrease in population levels. This pattern of change is evident when the northern is compared to southern portions of the island. Survey numbers increased on 5, remained the same on 1, and decreased on 5 routes in northern Guam and increased on 2, remained the same on 1, and declined on 11 routes in southern Guam.

Table 2. Numbers of Philippine Turtle-Doves observed per count and average number of birds per station as detected in spring game bird surveys at various locations on Guam during May and June 1990. Values in the trend column are the difference between the average station count between years.

Survey Location	No. Stations	No. Doves Observed	1990 Ave./ station	1989 Ave./ station	Trend in Ave. 90-8.9
Tarague	8	8	1.00	1.25	-0.25
CWA	10	18	1.80	1.80	0.00
NWF	10	27	2.70	1.70	1.00
NAVCAMS	10	11	1.10	0.70	0.40
Capitol Improvement Road	10	8	0.80	0.90	-0.10
MT. Santa Rosa	10	14	1.40	1.00	0.40
Two Lovers Point	10	7	0.70	0.60	0.10
Andy South	10	5	0.50	1.00	-0.50
Navy Golf Course Barrigada	10	16	1.60	2.30	-0.70
Barrigada Hill	10	4	0.40	0.14	0.26
Toto Pipeline	8	0	0.00	0.50	-0.50
Nimitz Hill	10	7	0.00	0.70	-0.70
Reserve Craft Beach Road	4	15	3.75	0.25	3.50
Orote Point	6	7	1.17	1.50	-0.33
Pulantat	10	4	0.40	0.29	0.11
Cross Island Rd.	10	4	0.40	0.70	-0.30
NAVMAG	10	5	0.50	0.50	0.00
Umatac	10	4	0.40	0.50	-0.10
Dandan	10	6	0.60	0.40	0.20
Ija	10	5	0.50	0.50	0.00
Merizo	8	7	0.88	1.50	-0.63
Cocos Island	10s	44	4.4	8.00	-3.60

RECOMMENDATIONS

1. Continue call count and roadside count surveys in northern Guam to monitor distribution, relative abundance and population trends of the Philippine Turtle-Dove.

2. Keep Philippine Turtle-Dove hunting season closed until nesting success improves and the population recovers.

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Sokal, R. R. and F. J. Rohlf. 1981. Biometry. W. H. Freeman and Co. 859 pp.

Report prepared by Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Territory Size, Movement Patterns, and Habitat Utilization of the Black Francolin.

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

No significant effort was expended on this job during this segment.

Report Prepared by: Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-2
SUB-PROJECT NO.: W
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Territory Size, Movement Patterns, and Habitat Utilization of the Black Francolin.

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

No significant effort was expended on this job during this segment.

Report Prepared by: Celestino F. Aguon

2. Keep Philippine Turtle-Dove hunting season closed until nesting success improves and the population recovers.

LITERATURE CITED

Baker, R.H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. University of Kansas Pub. 3(1):1-359.

Conry, P. J. 1987. Ecology of the Philippine Turtle-Dove on Guam. Tech. Report No. 6. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao.

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Sokal, R. R. and F. J. Rohlf. 1981. Biometry. W. H. Freeman and Co. 859 pp.

Report prepared by Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 2

JOB TITLE: Population Size and Distribution of Black Francolin on Guam.

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

An estimated 106 hunters spent 517 hunter days and harvested 536 birds during the January and July/August Black Francolin season, expending 1.04 hunter-days per bird taken. Cotal, Bolanos Territorial Conservation Reserve, Dandan, Ija and Mt. Alutom were identified as areas hunted this past year. Black Francolin were found on 14 of 22 spring game bird surveys conducted throughout the island during May and June 1989. The average number of birds detected per station increased on 10 survey routes and decreased on 5 between 1989 and 1990. There was no statistically significant ($p > 0.05$) pattern of change in the data and the differences in survey results between last year and now can be attributed to random fluctuations in local populations. Francolin occurred on all of the 11 survey routes in Southern Guam and on 3 of the 11 Northern Guam routes. The Merizo survey route continued to have the highest station counts this year with an average of 9.25 birds/station. Dandan had the highest relative increase in birds with the average station count increasing 3.9 birds/station. The Pulantat, Dandan, Ija, Umatac, Merizo, and Cross Island Road routes also had high (> 5.0 birds/station) average station counts. Francolin populations are well established throughout southern Guam and appear to be continuing to expand their range into shrub-grass habitats in central and northern Guam. This species appears able to sustain the current levels of recreational hunting.

BACKGROUND

In 1961, 171 Black Francolin *(Francolinus francolinus)* were introduced in southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted in 1980 indicated the population was adequately established in most parts of southern Guam to open a hunting season. Regulations were promulgated to open a 1-month season in December 1981 with a 4-bird daily limit and a 20-bird season limit. Francolin populations continued to increase from 1980-1982 but hunting pressure remained low, probably because of the unfamiliarity of the hunting public with the sporting qualities of the bird. With the bird population consistently increasing and little hunting pressure, the francolin season and bag limits were further liberalized in FY83 to a 2-month split season, 1 month in January and 1 month in July, and the bag limit was increased to 5 birds per day with no season limit. Revisions to the francolin season were again made in FY90 extending the season from January 1 to February 28 and from July 1 to August 31. Francolin hunting has increased in popularity and Guam hunters are successfully harvesting birds during the open seasons. Regulations implemented in FY83 remain in effect with hunter participation and adherence to game laws monitored by spot checks by Division biologists and conservation officers.

OBJECTIVES

To determine current relative abundance and current distribution of Black Francolin on Guam and monitor population trends and hunter harvest.

PROCEDURES

1. Conduct annual island-wide spring game bird surveys (station counts) to monitor distribution and status of francolin throughout the island.

2. Conduct twice weekly station-count surveys during May-June to monitor pre-hunting season status of francolin population in Dandan, Inarajan.

3. Monitor hunter harvest via an annual harvest questionnaire. Collect information on hunter participation, effort, harvest, and areas hunted.

RESULTS

Francolin Hunting Statistics

License sales increased 15% during FY90 with 648 sold during the year. Only 450 license holders were mailed harvest questionnaires and responses were obtained from 104 persons (23%). Outdated or incomplete mailing addresses continue to be a problem and 6% of the mailed questionnaires were returned as undeliverable. Of the 104 persons responding to the questionnaire, 65% indicated they had hunted at some time during the October 1 - September 30 licenses year. Based on that percentage, an estimated 424 people legally hunted game during FY90.

Twenty-five percent of the responding hunters reported they hunted francolin during the license year, 15% during the January season and 10% during the July/August season (Table 1). Hunter success was 90% in January, 57% in July/August and 76% for the year. The hunters that responded to our questionnaire took an average of 5.4 birds in January, 4.6 birds in July and 5.1 birds overall. Francolin hunters expended an average of 4.8, 5.0, and 4.9 days hunting in January, July, and over the entire season, respectively. No 5-bird daily limits were taken during the year.

Estimates of total hunter participation, effort, and harvest were based on hunter questionnaires. In FY90, an estimated 106 hunters spent 517 hunter days and harvested 536 birds over the entire season. The hunter statistics for FY90 indicated an 8% increase in hunter participation, 29% decrease in hunter effort, and a 17% decrease in harvest over FY89 levels (DAWR 1989). The hunting effort expended per bird harvested was 0.89 days/bird in January, 1.09 days/bird in July/August, and 1.04 days/bird overall.

Although the data indicated a slight decrease in hunter activity this past season, the estimated total effort and harvest seemed far higher than actual activity and are likely over-estimates of hunter activity. These results reflect the bias typical of hunter questionnaires where successful hunters are far more likely to report their activities than unsuccessful ones. Consequently, information derived from this questionnaire is more useful as an index of hunter activity rather than an absolute estimate of it.

Cotal and Bolanos Territorial Conservation Reserves, Dandan, Ija,and Mt. Alutom were identified as areas hunted this past year. No hunters reported they hunted with a bird dog.

Table 1. Black Francolin (BLFR) harvest statistics for FY90.

		Jan 90	Jul/Aug 90	Total
a.	Total license sales for year			648
b.	Hunter questionnaires mailed out			450
c.	Number of hunter questionnaires returned			104
d.	Percent of license buyers reporting			23%
e.	Number of respondents (136) that hunted any species			68
f.	Percent of license buyers that hunted			65%
g.	Estimated total number of legal hunters			424
h.	Number of reporting hunters that hunted BLFR	10	7	17
i.	Percent of reporting hunters that hunted BLFR	15%	10%	25%
j.	Number of successful BLFR hunters	9	4	13
k.	Hunter success	90%	57%	76%
l.	Number of BLFR taken by reporting hunters	54	32	86
m.	Average number of BLFR taken per hunter	5.4	4.6	5.1
n.	Average number of BLFR taken per successful hunter	6.0	8.0	6.6
o.	Reported number of days spent hunting	48	35	83
p.	Average number of days spent hunting	4.8	5.0	4.9
q.	Estimated total number of legal BLFR hunters	62	44	106
r.	Estimated total legal BLFR harvest	336	199	536
s.	Estimated total number of days spent hunting	299	218	517
t.	Number of days spent hunting per BLFR taken	0.89	1.09	0.97
u.	Number of BLFR taken per day hunting	1.13	0.91	1.04
v.	Number of 5-bird daily limits	0	0	0

Spring Game Bird Surveys

Black Francolin were detected on 14 of 22 spring game bird surveys conducted during May and June 1990 (Table 2). Francolin were found on 9 of the 11 surveys south of Route 4. Francolin were detected on the Reserve Craft Beach and a single calling male was observed on the Cocos Island survey where they have never been previously recorded. For the fourth year in a row, francolin were located at an additional survey site north of Route 4 at Two Lovers Point. Francolin were found on 3 of the 11 routes in northern Guam. Other sightings of francolin in northern Guam include one calling male at the south end of the airfield of Andersen Air Force Base. These new sightings indicate this species is continuing to increase its range in northern Guam although it appears to occur in small numbers only in these areas.

The Merizo survey route continues to have the highest station counts this year with an average of 9.25 birds/station, the same as last year. Dandan had the highest relative increase in birds with the average station count increasing 3.9 birds/station. The Pulantat, Dandan, Ija, Merizo, Umatac, and Cross Island Road routes also had high (> 5.0 birds/station) average station counts. The average number of birds detected per station increased on 10 survey routes and decreased on 5 between 1989 and 1990. There was no statistically significant (Wilcoxon Signed-rank Test, $Z = -2.26$, $p > 0.05$) pattern of change in the data and the differences in survey results between last year and now can be attributed to random fluctuations in local populations. Francolin populations remain well established and stable throughout southern Guam and appear to continue to expand their range into shrub-grass habitats in central and northern Guam.

Table 2. Numbers of Black Francolin (BLFR) observed per count and average number of birds observed per station as detected in spring game bird surveys at various locations on Guam during May and June 1990. Values in the trend column are the difference between the average station count between years.

Survey Locations	No. Stations	No. Birds Observed	1990 Ave./ station	1989 Ave./ station	Trend in Average 90-89
Tarague	8	0	0.00	0.00	0.00
CWA	10	0	0.00	0.00	0.00
NWF	10	0	0.00	0.00	0.00
NAVCAMS	10	0	0.00	0.10	-0.10
Capitol Improvement Road	10	0	0.00	0.00	0.00
MT. Santa Rosa	8	0	0.00	0.00	0.00
Two Lovers Point	10	14	1.40	0.00	1.40
Andy South	10	0	0.00	0.00	0.00
Navy Golf Course Barrigada	10	32	3.20	3.80	-0.60
Barrigada Hill	7	25	2.50	1.86	0.64
Toto Pipeline	8	0	0.00	0.13	-0.13
Nimitz Hill	10	45	4.50	2.80	1.70
Reserve Craft Beach Road	4	5	1.25	0.00	1.25
Orote Point	6	20	3.33	3.67	-0.34
Pulantat	7	84	8.40	7.71	0.69
Cross Island Rd.	10	61	6.10	5.30	0.80
NAVMAG	10	37	3.70	3.90	-0.20
Umatac	10	82	8.20	5.70	2.50
Dandan	10	88	8.80	4.90	3.90
Ija	10	65	6.50	6.30	0.20
Merizo	8	74	9.25	9.25	0.00
Cocos Island	10	1	0.10	0.00	0.10

RECOMMENDATIONS

1. Continue to monitor francolin population status, distribution, and hunter harvest.

2. Increase the response rate to annual hunter questionnaire survey.

LITERATURE CITED

Division of Aquatic and Wildlife Resources. 1988. Job Progress Report. Federal Aid to Fish and Wildlife Restoration. DAWR, Dept. of Agriculture, Mangilao, Guam.

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Report prepared by Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: FW-2R-27
SUB-PROJECT NO.: W-3
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Wild Asiatic Water Buffalo on Guam

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

The abundance of wild (feral) Asiatic water buffalo (*Bubalus bubalis*) on Naval Magazine showed a non-significant decrease during FY90.

BACKGROUND

Asiatic water buffalo, known locally as carabao, were introduced to Guam in the 1600s for use as beasts of burden. Some of the island's domestic animals were reportedly let loose during World War II, resulting in the formation of a feral population in south-central Guam in the vicinity of the U.S. Naval Magazine (Anderson 1980). Research on feral water buffalo on Naval Magazine began in about 1966 when the Division of Aquatic and Wildlife Resources (DAWR) began to conduct spotlight counts of buffalo in conjunction with sambar deer (*Cervus unicolor*) censuses. The size of Naval Magazine's buffalo herd remained fairly constant between 1966 and 1978, averaging about 0.6-0.8 animals/km traveled during counts (Anderson 1980). The population began to increase in 1979 and peaked in 1982, when a mean of 2.6 animals/km traveled was recorded (DAWR 1980-1982). Buffalo abundance declined thereafter, with counts remaining fairly constant at means of about 1.5-1.7 animals/km traveled from 1986-1988 (DAWR 1983-1988). In 1987, Biosystems Analysis Inc. (1989) estimated the buffalo population on the base to contain 75-150 animals. In 1989, buffalo numbers on DAWR spotlight counts increased to an average of 2.5 animals/km traveled (DAWR 1989). Illegal hunting appears to be the major cause of mortality in the population (Conry 1988). High buffalo densities have resulted in localized habitat damage on Naval Magazine (Conry 1988, Biosystems Analysis Inc. 1989).

OBJECTIVES

To monitor the status of the wild Asiatic water buffalo population on Guam and to determine if control measures are necessary to maintain the population at a level compatible with the available resources.

PROCEDURES

1. Conduct monthly spotlight counts on Naval Magazine. Analyze count data and compare with past data to estimate population trends.

RESULTS

The average number of water buffalo seen per spotlight count on Naval Magazine exhibited a non-significant decrease from 56.3 animals in FY89 to 44.3 animals in FY90 (Mann-Whitney U-Test, U=52, P>0.10) (Table 1). The mean for FY90 corresponded to 1.8

animals seen per km, or 2.9 animals per mile, of counting. The largest number of water buffalo recorded on a monthly count declined from 85 animals in FY89 to 71 animals in FY90.

Table 1. Results of monthly spotlight counts of feral water buffalo at Naval Magazine, FY90.

Month	No. animals observed	Km traveled	Animals/ km	Miles traveled	Animals/ mile
Oct	53	24.0	2.2	14.9	3.6
Nov	71	24.0	3.0	14.9	4.8
Dec	61	24.0	2.5	14.9	4.1
Jan	49	24.0	2.0	14.9	3.3
Feb	66	25.6	2.6	15.9	4.2
Mar	29	24.2	1.2	15.0	1.9
Apr	41	24.2	1.7	15.0	2.7
May	27	26.6	1.0	16.5	1.6
Jun	50	22.7	2.2	14.2	3.5
Jul	18	24.3	0.7	15.1	1.2
Aug	16	25.3	0.6	15.7	1.0
Sep	50	24.2	2.1	15.0	3.3
Total	531	293.1	21.8	182.0	35.2
Ave	44.3	24.4	1.8	15.2	2.9
SD	18.25		0.78		1.25
CV(%)	41.2		42.9		42.5

No additional work to assess the population parameters of the Naval Magazine herd was done during the year because of limitations in manpower.

RECOMMENDATIONS

Continue monthly spotlight counts of water buffalo at Naval Magazine. Additional aerial and ground surveys should be made as conducted in FY89 (DAWR 1989). An investigation into the impacts of water buffalo on Naval Magazine's vegetation should be initiated. The construction of an enclosure on the base would help to evaluate damage to plant communities caused by browsing and wallowing. Other study activities should be expanded to obtain more biological information on diet, population characteristics, movements and general distribution, and causes of mortality.

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Report prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUBPROJECT NO: W-4
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Survey and Inventory of Non-Game Birds

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

Roadside count data continues to document the decline of Guam's native forest birds. Introduced birds showed some increase in the North and North-Central roadside counts. Northwest Field (NWF) and Conventional Weapon Storage Area (CWSA) on Anderson Air Force Base (AAFB) remain the center of distribution for most of Guam's remaining forest birds. The Mariana Crow population is estimated to be about 100 on Guam. Guam's Island Swiftlet population increased from approximately 290 birds to 400 birds during the year. A second colony of Island Swiftlets was discovered on Naval Magazine and held about 50 birds until flooding closed the cave off in September. The total estimated population of swiftlets on the island increased for the second consecutive year to about 470 birds.

BACKGROUND

Since the early 1960's, census data has documented the decline in both range and numbers of Guam's native land birds. Roadside counts initiated in 1960 over four routes in southern, central and northern Guam by the Guam Division of Aquatic and Wildlife Resources (DAWR) have provided an index to the decline (DAWR, 1974-1988). From 1979 to 1981 estimates of the population trends were made by the DAWR based on variable circular-plot techniques (Reynolds et al. 1980) and from station counts in central and northern Guam (DAWR 1980-1982). From June to July of 1981, an intensive forest bird survey utilizing variable-circular plot techniques along randomly located transects was conducted by the U.S. Fish and Wildlife Service with the cooperation of the DAWR (Engbring and Ramsey, 1984). Some of these transects have been repeated in recent years by the DAWR (1982-1988). In 1987, surveys for the Island Swiftlet were begun at the only known remaining nest cave located on Naval Magazine in central Guam.

Native land birds are now primarily restricted to northern Guam with the center of distribution of remaining native forest birds located on Northwest Field, Conventional Weapons Area and adjacent cliffline areas at AAFB. Exceptions are the Island Swiftlet (known only from one cave in central Guam), Mariana Common Moorhen (found over most of Guam in restricted and declining wetlands), Micronesian Starling (found on Cocos Island, southeast coast and various urban areas), and the Yellow Bittern (declining but found in savannah and second-growth vegetation over the entire island) (DAWR 1974-1988).

Predation by the brown tree snake, *Boiga irregularis*, is believed to be the major factor contributing to recent declines in Guam's native bird populations (Conry 1988; Savidge 1986, 1987).

A captive breeding program for the Guam Rail and Guam subspecies of the Micronesian Kingfisher was successfully begun in 1983 on Guam and at mainland U.S. zoos in cooperation with the American Association of Zoological Parks and Aquariums (DAWR 1984-1988; Derrickson 1986; Shelton 1986).

OBJECTIVES

To continue status surveys and natural history studies as called for in the Recovery Plans for Guam's various endangered native birds.

PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes in northern Guam (Figure 1) by DAWR Conservation Officers. These routes were driven at approximately 6-9 km per hour beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.

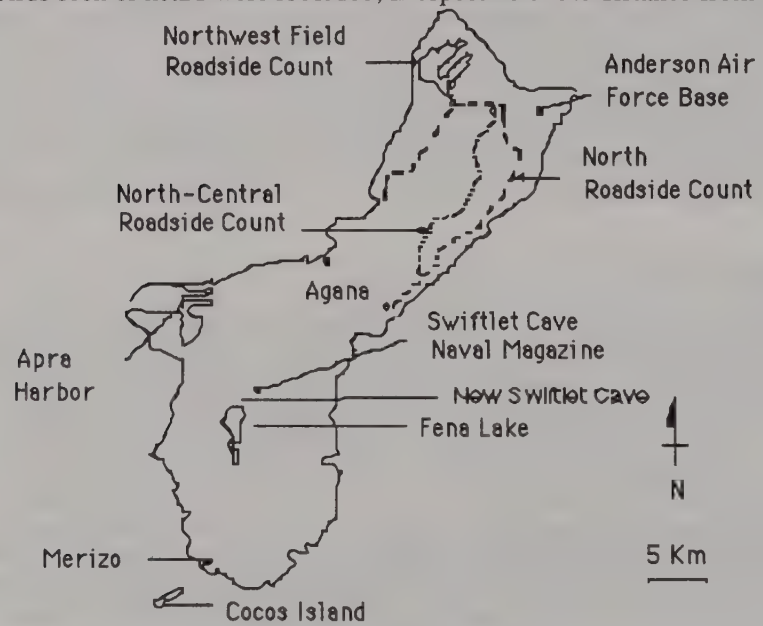

Figure 1. Map of Guam showing the locations of Roadside Counts and the two known Island Swiftlet Caves.

2. Monthly counts of Island Swiftlets were conducted at the swiftlet cave near Firebreak 4 on Naval Magazine. Observers sat at both entrances of the cave for a period of 2-2.5 hours before dark and recorded the numbers of birds flying in and out. The total number of birds inhabiting the cave was determined by subtracting the number of departures from the number of arrivals and by adding the number of birds estimated to be in the cave at the start of the count. Prior to each count, observers entered the cave for 0.5-1 hour to look for evidence of nesting and reproductive activity. The presence of nestlings and their calls and the incidence of adult birds that appeared to

be incubating eggs or brooding young were noted. In order to avoid disturbing nesting birds, nests were viewed from a slightly elevated position off to the side of the cave rather than by lifting a mirror up to look inside the nests. The cave floor was searched and cleaned each month of eggshell fragments and whole eggs that had fallen from nests overhead.

3. Recorded-call playback surveys for crows were conducted in the northern areas of Guam. For a detailed description of procedures and results see Appendix A.

RESULTS

Roadside counts done on the North, North-Central and Northwest Field routes in northern Guam (Figure 1) continued to document the status of native forest birds.

On the North roadside count (Table 1), 7 species were counted as compared to 9 species during FY89. Only one native forest bird, the Mariana Crow was observed FY90, whereas two native forest birds were observed in FY89.

Table 1. Average number of birds per 100 Km observed each month on the North roadside counts during FY90.

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Total	X/Count	X/100 Km
Yellow Bittern					1	2					2	2	7	0.30	0.83
Mariana Crow				6									6	0.26	0.71
Black Drongo	5	5	2	1		4	6			3	4		30	1.30	3.55
Rufous Fantail															
Mariana Fruit-Dove															
Guam Flycatcher															
Golden Plover	69	55	23	70	98	75	67					10	467	20.30	55.29
White-throated Ground-Dove															
Cardinal Honeyeater															
Micronesian Kingfisher															
Brown Noddy															
P.T. Dove	8	4	4		3	1	1		1	1	4	1	28	1.22	3.32
Blue-breasted Quail															
Guam Rail															
Chestnut Mannikin															
Eurasian Tree Sparrow	2	6	2	4	2	39	21	3	35	2	9	3	128	5.57	15.16
Micronesian Starling															
White Tern															
Black Francolin									2				2	0.25	0.24
Km	76	72	69	79	77	70	73	74	66	77	76	37	845		
Miles	47	45	43	49	48	43	46	46	41	48	47	23	525		
Counts	2	2	2	2	2	2	2	2	2	2	2	1	23		

The Black Francolin originally introduced to Southern Guam in 1961 was observed for the second consecutive year on this route. Black Drongos continued to decline (Table 2). Eurasian Tree Sparrows continued to show an increase begun in FY87. Philippine Turtle-Doves declined by more than half as compared to FY89.

Table 2. Average number of birds per 100 km observed each fiscal year on the North roadside counts between 1984 and 1990.

Species	FY84	FY85	FY86	FY87	FY88	FY89	FY90
Yellow Bittern	4.2	2.3	2.06	2.41	1.95	0.45	0.83
Mariana Crow	0.3	0.4	0.1			0.23	0.71
Black Drongo	23.7	12.2	13.22	10.35	9.85	7.23	3.55
Rufous Fantail							
Mariana Fruit-Dove							
Guam Flycatcher							
Golden Plover	66	49.1	65.12	54.06	55.67	71.21	55.29
White-throated Ground-Dove			0.2				
Cardinal Honeyeater		0.1					
Micronesian Kingfisher		0.1					
Brown Noddy							
P.T. Dove	9.9	6.3	8.13	9.27	10.19	8.13	3.32
Blue-breasted Quail							
Guam Rail							
Chestnut Mannikin						0.45	
Eurasian Tree Sparrow	6.6	5	8.91	7.59	9.85	13.45	15.16
Micronesian Starling			0.88			0.11	
Bridled White Eye							
White Tern		0.5		0.36			0.24
Black Francolin						0.89	

Six species were observed on the North-Central count (Table 3).

Table 3. Average number of birds per 100 Km observed each month on the North-Central roadside counts during FY90.

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Total	X/Count	X/100 Km
Yellow Bittern		2					5	7	2	4		3	23	1.00	5.11
Mariana Crow															
Black Drongo	14	6	7	3	2	5	8	5	6	7	12	10	85	3.70	18.90
Rufous-Fantail															
Mariana Fruit-Dove															
Guam Flycatcher															
Golden Plover	159	141	88	203	21	269	289	1		2	1	107	1281	55.70	284.79
White-throated Ground-Dove															
Cardinal Honeyeater															
Micronesian Kingfisher															
Brown Noddy															
P.T. Dove	10	8	2	3		4	10		2	1	8	5	53	2.30	11.78
Blue-breasted Quail															
Guam Rail															
Chestnut Mannikin															
Eurasian Tree Sparrow	1		2	3	5	9	9	4	12	4	30	35	114	4.96	25.34
Micronesian Starling															
White Tern									9				9	0.39	2.00
Black Francolin															

Km	39.9	40	40	38	19	38.3	39	39	37	37	42	41.5	450
Miles	24.8	25	25	24	12	23.8	24	24	23	23	26	25.8	280
Counts	2	2	2	2	1	2	2	2	2	2	2	2	23

The seven years data shown on Table 4 found only one native bird observed, the Yellow Bittern. The Black Francolin and Chestnut Mannikin, observed on this route during FY88-89 was not observed during FY90. The Eurasian Tree Sparrow showed a large increase from FY89 to 90.

Table 4. Average number of birds per 100 Km observed each fiscal year on the North-Central roadside counts between 1984 and 1990.

Species	FY84	FY85	FY86	FY87	FY88	FY89	FY90
Yellow Bittern	6.7	2.4	3.22	5.04	3.1	2.27	5.11
Mariana Crow	2		0.76	0.88			
Black Drongo	44.38	30.9	25.57	22.14	26.14	24.57	18.90
Rufous Fantail	0.4						
Mariana Fruit-Dove	0.2						
Guam Flycatcher							
Golden Plover	362.69	240.8	483.27	437.92	397.4	289.72	284.79
White-throated Ground-Dove							
Cardinal Honeyeater	0.4						
Micronesian Kingfisher	1.1						
Brown Noddy							
P.T. Dove	34.9	39	37.89	37.26	35.89	24.78	11.78
Blue-breasted Quail							
Guam Rail							
Chestnut Mannikin	1.3	0.8		3.29	1.77	2.27	
Eurasian Tree Sparrow	13.9	22.9	36.75	13.59	17.5	7.64	25.34
Micronesian Starling	1.3	1.3					
Bridled White Eye							
White Tern	1.8	1.8		1.53		0.21	2.00
Black Francolin					9.75	11.98	

On the Northwest Field Roadside Count (Tables 5 and 6.), two native birds, the Mariana Crow and Yellow Bittern, were observed during FY90. Both showed a slight decrease in numbers (Table 6). NWF remains the last area to have a population of the Mariana Crow on Guam. A recent survey by DAWR biologists now estimates the current population of crows on Guam to number around 100 individuals (see Appendix A for complete description of results). Table 6, the six-year summary, documented the continuing six year decline of the introduced Philippine Turtle-Dove, Eurasian-Tree Sparrow and Black Drongo.

Table 5. Average number of birds per 100 Km observed each month on the Northwest Field roadside counts during FY89.

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	X/Coun	X/100 Km
Yellow Bittern			3	1	1			2	3		1		11	0.52	2.99
Mariana Crow	6		2	4	2	1	6	3	4	7		3	38	1.81	10.33
Black Drongo	20	13	10	21	5	8	10	23	35	13	23	14	195	9.29	53.00
Rufous Fantail															
Mariana Fruit-Dove															
Guam Flycatcher															
Golden Plover	47	56	15	73	50	21	22	1			8	67	360	18.00	97.85
White-throated Ground-Dove															
Cardinal Honeyeater															
Micronesian Kingfisher															
Brown Noddy															
P.T. Dove	17	6	3	20	3	6	12	14	24	14	11	21	151	7.55	41.04
Blue-breasted Quail															
Guam Rail															
Chestnut Mannikin											2		2	0.10	0.54
Eurasian Tree Sparrow					3								3	0.15	0.82
Micronesian Starling															
White Tern															
Black Francolin															
Km	38	17.5	19	36	36	18	18	35.7	38.1	37.5	38.9	36	368		
Miles	24	10.9	12	22	22	11	11	22.2	23.7	23.3	24.2	22	229		
Counts	2	1	1	2	2	1	1	2	2	2	2	2	20		

Table 6. Average number of birds per 100 Km observed each fiscal year on the Northwest Field roadside counts between 1984 and 1990.

Species	FY84	FY85	FY86	FY87	FY88	FY89	FY90
Yellow Bittern	9.90	3.70	11.62	4.69	2.72	4.73	2.99
Mariana Crow	32.50	28.60	19.44	13.85	10.90	13.68	10.33
Black Drongo	439.10	369.00	282.64	115.96	71.82	54.48	53.00
Rufous Fantail	2.70						
Mariana Fruit-Dove	2.70	0.60					
Guam Flycatcher							
Golden Plover	51.60	17.40	88.26	101.66	114.91	149.99	97.85
White-throated Ground-Dove	1.70	0.60	2.68				
Cardinal Honeyeater	8.90						
Micronesian Kingfisher	9.50	4.60	1.12	0.45	0.25		
Brown Noddy							
P.T. Dove	175.23	159.90	123.11	81.11	60.88	41.79	41.04
Blue-breasted Quail							
Guam Rail	0.30	0.30	0.22				
Chestnut Mannikin	2.00	0.90	1.34				0.54
Eurasian Tree Sparrow	8.20	0.30	5.36	2.46		1.49	0.82

Micronesian Starling	20.40	6.00	2.01
Bridled White Eye			
White Tern	0.70	1.40	0.89
Black Francolin			

Roadside census work (Table 7), observations made incidental to Philippine Turtle-Dove counts (DAWR 1990) and Mariana Crow nest snakeproofing (DAWR 1990) suggest that NWF and CWSA on AAFB remain the center of distribution of most of Guam's remaining native forest avifauna.

Table 7. Results of Northwest Field, North, and North-Central roadside counts showing the mean number of birds per 100 Km of travel, the standard deviation (SD) and the coefficient of variation (CV).

	Northwest Field			North			North Central		
Species	X/100 Km	SD	CV	X/100 Km	SD	CV	X/100 Km	SD	CV
Yellow Bittern	2.99	0.98	32.80	0.83	0.63	76.61	5.11	1.81	35.38
Mariana Crow	10.33	1.99	19.27	0.71	1.25	176.11			
Black Drongo	53.00	6.22	11.74	3.55	1.49	41.96	18.90	2.40	12.71
Rufous Fantail									
Mariana Fruit-Dove									
Guam Flycatcher									
Golden Plover	97.85	17.23	17.60	55.29	23.14	41.85	284.79	59.87	21.02
White-throated Ground-Dove									
Cardinal Honeyeater									
Micronesian Kingfisher									
Brown Noddy									
P.T. Dove	41.04	4.29	10.44	3.32	1.57	47.22	11.78	2.49	21.17
Blue-breasted Quail									
Guam Rail									
Chestnut Mannikin	0.54	0.45	82.26						
Eurasian Tree Sparrow	0.82	0.67	82.26	15.16	8.33	54.98	25.34	8.69	34.28
Micronesian Starling									
White Tern							2.00	1.88	93.79
Black Francolin				0.24	0.71	298.61			

Island Swiftlets

The numbers of Island Swiftlets counted during censuses at the Firebreak 4 (Mahlac) Cave on Naval Magazine increased from an estimated 290 birds at the end of FY89 to about 420 birds during FY90 (Table 8). Excluding two low counts in early April and late July that were likely to be in error, census results showed a gradual increase throughout the year. However, in contrast to previous years, most of the increase appeared to occur from October to December, which is outside the period considered to be the primary breeding season (DAWR 1987-1989). The increase in swiftlet numbers in this cave continues to be encouraging and shows that the population is recovering from the sudden decline that occurred in June and July 1988 (DAWR 1988).

Reproductive indicators continued to be recorded in FY90 (Table 8) and agreed fairly closely with data collected in previous years (DAWR 1987-1989). Evidence of breeding was found year-round, although most activity was noted from March to July.

Table 8. Results of censuses for Island Swiftlets at Firebreak 4 Cave and Fachi Cave on Naval Magazine during FY90. Evidence of reproductive activities of swiftlets is also presented.

				Reproductive Parameters				
Date	Net No. of Birds Entering Cave	No. of Birds Estimated in Cave at Start of Count	Total No. of Birds Counted	No. of Whole Eggs Found on Cave Floor	No. of Eggshell Fragments on Cave Floor	No. of Nestlings Heard	No. of Nestlings Seen	Incubation or Brooding Observed
Firebreak 4 (Mahlac) Cave								
27 Sept 1989	276	16	292	2	10	2	3	undetermined
31 Oct	304	25	329	2	5	2-3	0	no
5 Dec	328	16	344	0	5	2-3	0	undetermined
28 Dec	356	25	381	0	5	3+	1	undetermined
4 April 1990	275	38	313	7*	40*	3-4	4-5	undetermined
3 May	371	29	400	3	13	2-3	2	undetermined
30 May	386	15	401	0	12	2-3	2-3	undetermined
24 July	284	33	327	4*	23*	1	0	yes
25 Sept	295	22	417	0*	8*	2	2	undetermined
Fachi Cave								
20 March	2	36	38	0*	0*	2-3	0	undetermined
14 June	2	51	53	1*	-	2-3	1	undetermined
19 Sept	0	0	0•	-	-	0	0	no

Key: *note that more than one month had occurred between visits; - = no data gathered; • = cave was flooded

Low to moderate numbers of snake tracks were found on the surface of guano deposits on the cave floor in each of the eight visits to the cave. Two snakes were captured on a tall rock face approximately 30-40 m south of the cave's south entrance. The sizes and other relevant data from these animals were as follows: 1) MJM 1797, in early April, male, snout-vent length = 1,016 mm, weight = 127.7 gr, stomach contained unidentified gecko remains; 2) MJM 2087, in late September, female, snout-vent length = 715 mm, weight = 37.9 gr, stomach was empty. In late July, a shed snakeskin with a SVL of 975 mm was found inside the cave on the floor between the active aggregation of swiftlet nests and the north entrance. Feces-like clumps of swiftlet feathers were collected from the floor of the cave in early October. These may have been snake droppings (see DAWR 1989).

In early March, a second swiftlet colony was discovered on Naval Magazine by wildlife technician Ester Arca as she was exploring for caves with several Marines from the base. This cave, which was given the name of Fachi Cave because of its extremely muddy floor, is located about 850 m west of Firebreak 4 Cave. It was mapped and first censused on 20 March, when 38 birds and 20 nests were recorded. On 14 June, a second census of 53 birds was made by cautiously counting the number of birds seen on nests and cave walls after the entire colony had entered the cave for roosting in the evening. This was considered to be an exact count of the colony.

Fachi Cave was visited a third time on 19 September, when both of its entrances were found to be closed off by high flood waters following heavy rains in August and September. A number of swiftlets approached and circled within several feet of the closed-off east entrance of the cave in an apparent effort to find their way inside. Gary Wiles and Mike Ritter swam into the cave and confirmed that the birds were unable to enter it. They also noted that only four nests remained attached to the cave's walls. Any nestlings that may have been in the cave at the time of flooding would have been lost, either through abandonment by their parents or by drowning after their nests fell into the water.

On 21 September, Wiles observed two swiftlets foraging over limestone forest along the cliffline in Asdonlucas, Yigo at a location approximately halfway between Pagat and Bijia Points. This area has not been previously visited by biologists from the DAWR, and thus it is possible that the birds could be part of a small previously undiscovered colony that has continued to survive in this area. The location of the birds is 2.3 km southwest of a former swiftlet colony site at Janum Point and about 6 km northeast of another abandoned cave reported to be on the Marbo Cliffline.

Mariana Crow

Roadside and forest recorded-call playback surveys for crows were conducted from May to August 1990. Data from these surveys have been written up as a draft manuscript and are presented here as Appendix A of this report.

Native Doves

One record of a Mariana Fruit-Dove was made during roadside counts for turtle-doves this year. A bird was heard was heard calling on 11 April 1991 in the CWA. This species was last seen on the CWA and NWF dove surveys in FY '85 and FY89, respectively. Also during the year, there was a record of a White-throated Ground-Dove calling in the CWA on 6 September 1989.

Mariana Common Moorhen

Research into the abundance and distribution of the moorhen on Guam was basically inactive during FY90 due to manpower and budget constraints. Only one survey of Fena Valley Reservoir was completed and no other wetlands were surveyed on a regular basis. A manuscript entitled "The Mariana Common Moorhen: Decline of an Island Endemic" was submitted and accepted for publication in the February 1991 issue of *Condor*. This paper was co-authored by two staff members from the Commonwealth of the Northern Mariana Islands' Division of Fish and Wildlife and Mike Ritter of the DAWR.

RECOMMENDATIONS

1. Continue bimonthly roadside counts over the three routes in northern Guam.

2. Continue census of the Guam Rail in areas where appropriate.

3. Continue to census the Mariana Crow in order to estimate population size and distribution on Guam.

4. Continue breeding biology studies and attempts to snake proof nest sites of the Mariana Crow on Guam.

5. Continue monthly cave censuses and efforts to assess population change and reproductive activity of Island Swiftlets.

6. Consider snake-proofing the Firebreak 4 Cave used by swiftlets.

7. Conduct further observations on the foraging behavior of swiftlets. Determine whether there is any seasonal variation in the foraging range of the colony. Interview farmers in the Talofofo River valley about the use of pesticides on their farms.

8. Develop and implement methods for control of the brown tree snake.

9. Continue efforts to captive breed endemic endangered native land birds on Guam and at stateside zoos.

10. Implement plans to translocate captive bred Guam Rails to Rota, C.N.M.I. for purposes of establishing a wild population in a snake-free environment.

11. Continue to monitor the populations of the Mariana Common Moorhen and develop an appropriate habitat improvement and development program.

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Report prepared by: Robert E. Beck, Jr. and Gary J. Wiles.

APPENDIX A

The Current Distribution and Abundance of the Mariana Crow, *Corvus kubaryi*, on Guam

INTRODUCTION

Six species of indigenous forest birds have recently dissappeared or become very rare on Guam due primarily to predation by the brown tree snake (*Boiga irregularis*). The Rufous Fantail (Chichirika, *Rhipidura rufifrons uraniae*), Bridled White-eye (Nossak, *Zosterops conspicillatus conspicillatus*) and Cardinal Honeyeater (Egigi, *Myzomela cardinalis saffordi*) have not been seen in the past few years (Beck, pers. comm.). The Guam Flycatcher (Chiguangguang, *Myiagra oceanica*) was last seen in 1988 (Beck, pers. comm.). A recent citing of a single Mariana Fruit-Dove (Totot, *Ptilinopus roseicapilla*) was made in the Conventional Storage Area on Andersen Air Force Base. A few unconfirmed sightings of the White-throated Ground Dove (Paluma apaka/fache, *Gallicolumba xanthonura xanthonura*) have been made in the Mataguac, Yigo area. The Guam Rail (Koko, *Rallus owstoni*) and Micronesian Kingfisher (Sihek, *Halcyon cinnamomina cinnamomina*) have been extirpated from the wild but a captive population exists (Beck 1990).

The Mariana Crow (Aga, Corvus kubaryi), Micronesian Starling (Sali, *Aplonis opacus guami*) and Island Swiftlet (Yayaguak, *Aerodramus vanikorensis bartschi*) remain in the wild. Micronesian starlings are still found on Andersen Air Force Base, Agana, Ipao and the southeast coast of Guam from Inarajan and Merizo. A small but healthy population of starlings also remains on Cocos Island. A small population of the Island Swiftlet is present in the southern part of Guam. A population of about 50-100 crows are believed to remain in the northern tip of the island (Michael 1987, R. E. Beck pers. comm.). The Mariana Crow is endemic to Guam and Rota in the Mariana Islands and is the only corvid in to Micronesia. This small crow is believed to be descended from the *C. enca* stock of the Philippine and Malayan region (Baker 1951). However, Tomback (1986) cited Goodwin (1976) as saying that the Mariana crow could have descended from any other Corvus species. Literature on the biology of the Mariana crow is scarce. Baker (1951), Jenkins (1983), Tomback (1986) and Micheal (1987) have provided information on the biology and ecology of the crow but no long-term studies have been conducted on this species.

The purpose of this study was to determine the current distribution and abundance of the Mariana Crow based on systematic surveys of the northern part of the island of Guam. Since the survey work by Engbring and Ramsey (1984) in 1981, there have not been any extensive systematic surveys of northern part of the island. The brown tree snake has caused populations of native (as well as introduced) avian species to decline precipitously in the past two decades (Savidge 1986, 1987). Thus, it is important that decisions in managing native avian species be based on the most recent information concerning distribution and abundance.

MATERIALS AND METHODS

Roadside and forest recorded-call playback surveys for crows were conducted in Guam from May to August 1990. Of the 221 stations, 134 were along roadways, abandoned runways and jeep trails, and 87 were in forested areas. Stations on roadside surveys were 500 - 600 meters apart. Stations along forest transects were 300 m apart. The distance

between stations along forest transects was based on Engbring and Ramsey's (1984) detection distance for crows in forested areas. Because roadside surveys had open vistas for observing crows, the distance between these stations was increased to allow for greater area of coverage.

At each station, tape-recorded crow calls were played for 2.5 minutes. This was followed by a 2-minute silent period during which the observer listened for crows. The numbers and plumage condition of the crows observed were recorded. Incidental observations for crows were also made while traversing between stations. The number of birds recorded at each transect was taken to represent the absolute number of birds in that area.

The effectiveness of tape playback versus the circular plot survey method described by Reynolds and Scott (1981) and used by Engbring and Ramsey (1984) was tested. Twenty-eight station counts were made in the Conventional Storage Area, Northwest Field and Tarague area. A 5-minute stationary count (the "regular" station count) followed by a 2 minutes of playback and 2 minutes of listening (the playback count) was performed at each station. The number of crows observed was recorded

RESULTS

Playback recorded more crows (19) than stationary counts (9) birds. Six playback stations (21%) recorded crows while no birds were recorded during the stationary count. At one station (4%) the stationary count recorded a crow while playback failed to record any birds. Although the difference between the number of crows recorded by playback and stationary counts was not significant at the 95% level (G-test, G= 3.589, n = 28), it was significantly different at the 90% level (G-test, $p<0.1$, G=3.589, n = 28) suggesting that tape playback was more effective in locating crows.

A total of 15 transects which included 221 stations were used to survey the 9 regions in the northern part of the island of Guam as delineated by Engbring and Ramsey (1984) (Figure 1 and Table 1). Of the 15 transects, 10 transects or 67% recorded crows. A total of 107 crows were recorded during station playbacks and 7 additional crows were observed incidentally while traversing between stations.

Table 1. Summary of results from tape playback of recorded calls (Fig. 1 for locations). Incidental number of crows is the number observed while traversing between stations.

	TRANSECT														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
# Stations	50	36	12	10	8	11	10	23	9	9	7	9	8	8	11
# Crows Observed	36	28	5	0	0	1	16	0	1	4	5	0	3	5	0
Incidental # Crows Observed	0	0	0	1	0	4	0	0	0	0	0	0	2	0	0

The regions that recorded crows included the Magazine (Conventional Storage Area), which recorded 36 crows (see Figure 2 for locations of the regions). This roadside transect recorded crows at 18 of the 50 stations (36%). Northwest Field recorded the second largest number of crows with 31 birds observed. This region included transects 2, 5, 8, and 13 of which only transects 2 and 13 recorded crows. Seven stations along transect 2 recorded crows in forested areas along the old runway. Birds were observed also flying between forested areas over runways. Though transect 5 did not record any birds, crows have been observed recently utilizing this area (pers. obser.). The Andersen Air Force

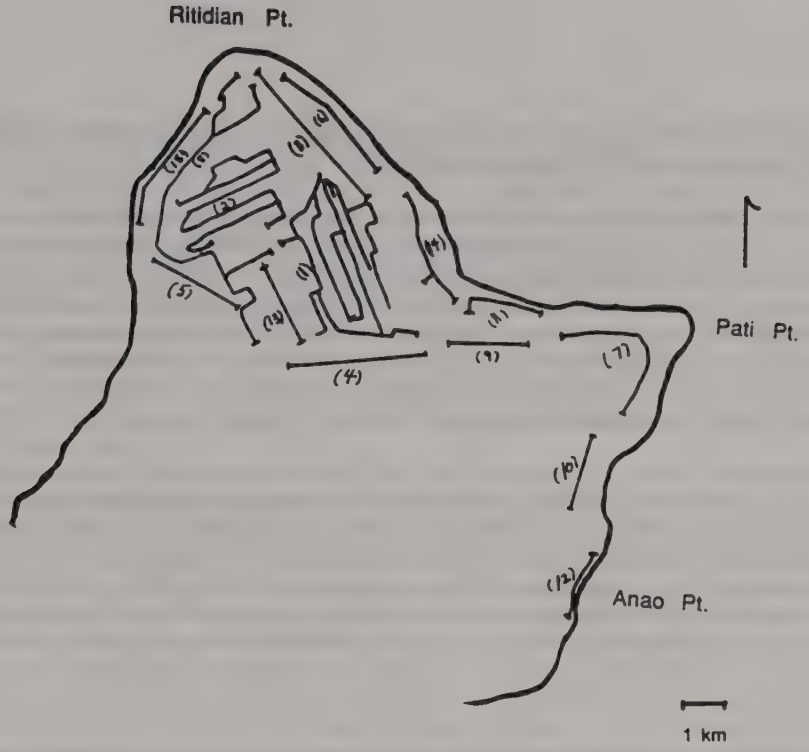

Figure 1. Location of transects in the northern areas of Guam. Transect number is denoted (#). Results of surveys for each transect are listed in Table 1.

Figure 2. Locations of regions in northern Guam (delineated by Enngbring and Ramsey, 1984) and adopted in this survey for comparison purposes.

Base region recorded 23 crows. In this region, 4 stations along Transect 7 (44%) and 5 stations along transect 10 (50%) recorded crows.

Fewer birds were recorded in other regions. The Tarague Basin (transects 11 and 14) recorded 10 crows and Tarague Plateau (transects 4 and 9) recorded only 1 crow. The Pajon Basin region recorded only a single bird, while the Pajon Plateau (transect 3) had 5 crows (a single bird at each of 5 stations). The Uruno area recorded no crows during the survey though 2 pairs of crows were probably utilizing the area based upon observations made independent of this survey (pers. obs., pers. comm. G. Witteman). Because of limited opportunity for access, that area was surveyed on a day with poor weather conditions. The Mount Santa Rosa region (transect 12) failed to record any crows.

When the number of crows recorded from the surveys is compared to the estimates made by Engbring and Ramsey (1984), all regions have experienced reductions in the number of birds (see Table 2). When compared to the number estimated by Engbring and Ramsey (1984), Andersen Air Force Base and the Magazine have experienced the smallest reduction in the number crows with 24% and 32% decrease, respectively. No birds were recorded in the Mt. Santa Rosa area, though Engbring and Ramsey had estimated 7 crows for this area. Uruno also recorded no crows though Engbring and Ramsey had reported about 12 crows for the area. Overall, the population of crows on Guam has declined 70 percent since 1981.

Table 2. Comparison of 1990 playback surveys with the results of reported (Engbring and Ramsey, 1984). Location abbreviations include the following: A = Anderson; B = Tarague Basin; C = Tarague Plateau; D = Magazine; E = Pajon Basin; F = Pajon Plateau; G = Northwest Field; H = Uruno and; I = Mt. Santa Rosa.

	A	B	C	D	E	F	G	H	I
1990 Survey									
No. Stations	19	15	19	50	11	12	75	11	9
No. Crows	23	10	1	36	1	5	31	0	0
1981 Survey									
No. Stations	6	17	4	14	12	22	48	15	6
No. Crows	31	161	32	99	32	148	172	72	53
Estimated No. Crows	25	29	19	53	5	30	61	12	7
% Reduction	24	65	95	32	80	83	49	100	100

DISCUSSION

In the 1970's, reports by Ralph and Sakai (1979) and of DAWR (Divsion of Aquatic and Wildlife Resources) roadside counts (Aguon 1982, Jenkins 1983) indicated the population of crows on Guam was very low. Ralph and Sakai (1979) reported the crow on Rota was uncommon and endangered and estimated the Rota population at 0.263 birds per hectare. However, Pratt et al. (1979) believed the crow to be common on Rota. Ralph and Sakai (1979) estimated crow density on Guam at 0.418 birds per hectare and also concluded it rare and endangered. Based on roadside surveys on Guam, Jenkins (1983) reported that crows were declining in the central areas and still in healthy numbers in the northern areas.

In the 1980's, roadside counts and stations counts were used by the DAWR to monitor forest bird populations. In 1981, the United States Fish and Wildlife Service as part of the inventory forest birds in territories of the USA, conducted a survey on Guam in cooperation with DAWR and estimated the population at 357 birds (Engbring and Ramsey 1984). A similar survey in 1982 on Rota reported the estimated population there to be at 1,318 birds (Engbring et al. 1986). Recent surveys suggest that the population is much smaller than what Engbring et al. (1986) had estimated (R. E. Beck, pers. comm.). However, the population on Rota has remained stable possibly since 1945 (Engbring and Pratt 1985). In contrast, the population on Guam has been declining and continues to decline to where fewer than 50 birds are believed to remain (Beck, pers comm.). Michael (1987), based on his own surveys, reported 100 birds left in the wild. He did not mention how he got this figure.

I estimate the number of crows at about 107 or more birds for the entire island of Guam. If the incidental sightings (7 birds) were added to the number recorded during the playback station counts the estimate would increase the total to 114. Generally, the numbers have decreased and the distribution of crows has receded slightly (see Figure 3). Though Engbring and Ramsey (1984) reported crows as far south as the Haputo area on the west side, there has been no recent incidental sightings of crows in these areas.

Though the results of this survey indicated that the population is a little larger than previously believed, I must add a caveat to these findings. First, the accuracy of the playbacks as a method for censuring crows remains unclear. The probability of drawing in other crows from adjacent territories and thus inflating the population estimate is always present and may lead to overestimation. Despite this, the fact that playbacks recorded significantly more crows (G-test, $p < 0.1$) than stationary call counts makes playback surveys a preferable technique. Second, there have been no sightings of fledglings or juveniles in the wild in the past 3 years (R. Beck, per. com). Thus, all the individuals recorded in this survey could quite conceivably be old. If there has been any successful reproduction in the past few years it must be very low.

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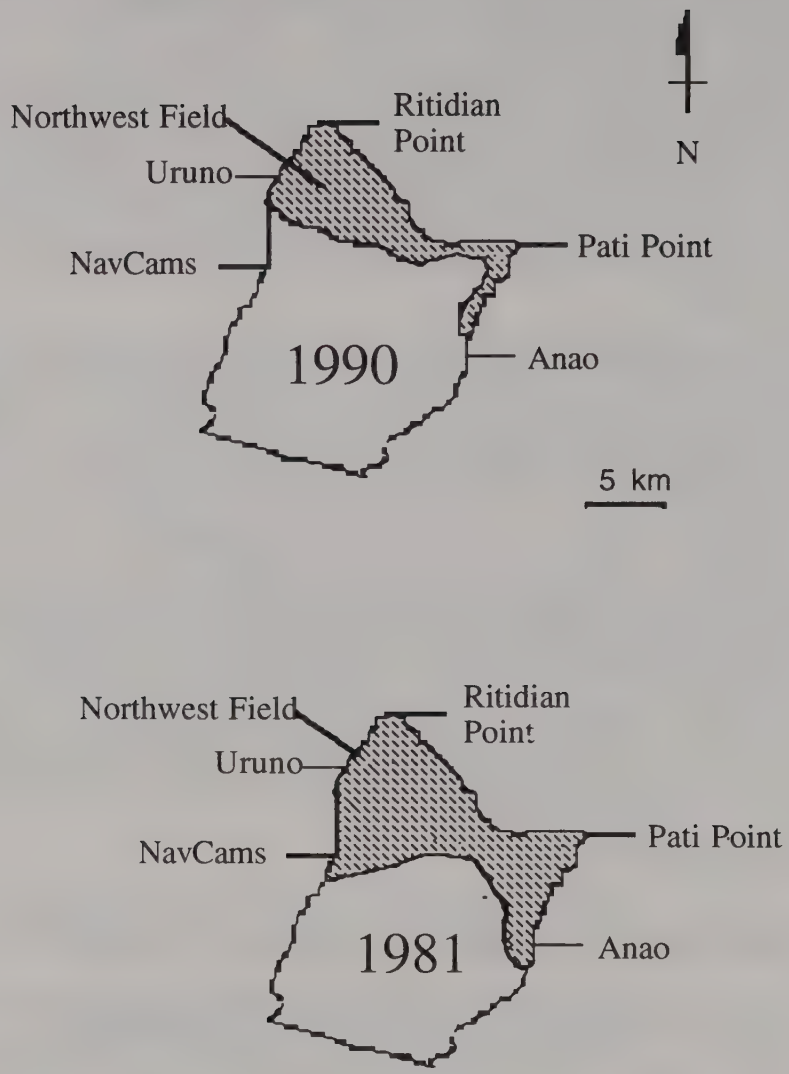

Figure 3. Comparison between the distribution of crows in 1981 and1990.

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Report prepared by: Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Natural History, Biology, and Habitat Protection for Marianas Fruit Bats

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

Guam's fruit bat population is currently estimated at 390-475 animals, which is a slight decline of about 35 bats from the previous year. Bat colonies used four roosts on Pati Point during the year. A low incidence of young bats was noted on Guam in March, in contrast to observations made on Rota. One suspected case of illegal hunting of fruit bats occurred during the year. In FY90, 10,051 frozen fruit bats were imported to Guam from other islands for human consumption, a decrease of 39.7% from the previous year. Imports declined significantly after 1 April, when new CITES restrictions were implemented. Assistance was given to the Commonwealth of the Northern Mariana Islands (CNMI) Division of Fish and Wildlife during a week-long census of bats on Rota in March.

BACKGROUND

The Marianas fruit bat (*Pteropus mariannus mariannus*) is endemic to the Mariana Islands and has been under investigation by the Guam Division of Aquatic and Wildlife Resources (DAWR) since 1962 (DAWR 1964-1989). These bats, considered a delicacy by Chamorro residents, steadily declined in number during the 1960s (Perez 1972). Thereafter, annual surveys revealed that only a few dispersed, solitary bats remained in suitable habitat on Guam which once supported colonies containing hundreds of bats (Wheeler and Aguon 1978, Wheeler 1979). Reasons for the decline included: increased human population pressures that resulted in overhunting and habitat loss, commercial exploitation of bats as food, periodic severe typhoons, the lack of an adequate enforcement staff, and delays by the local legislature in passing protective legislation (Wheeler 1979). The Marianas fruit bat and the little Marianas fruit bat (*P. tokudae*) finally received full protection from hunting in 1973. Both species were placed on Guam's territorial Endangered Species List in 1981 and on the U.S. Endangered Species List in August 1984, but *P. tokudae* is now thought to be extinct. The island's population of Marianas fruit bats grew substantially to an estimated 850 - 1,000 animals between 1980 and 1982, probably from immigration of bats from Rota (Wiles 1987a, Wiles and Glass in press). However, numbers have declined since 1983 because of continued illegal hunting and suspected predation on bats by brown tree snakes (*Boiga irregularis*) (Wiles 1987a, 1987b). Guam's fruit bat population was estimated at 425-510 animals in FY89 (DAWR 1989).

OBJECTIVES

To continue status surveys and natural history studies and to provide for continued protection of habitat as called for in the Fruit Bat Recovery Plan.

PROCEDURES

1. Survey fruit bat distribution and numbers in Guam and the Commonwealth of the Northern Mariana Islands (CNMI) as initiated in the late 1970s.

    a. Conduct annual surveys of fruit bats along Guam's northern cliffline with periodic surveys made elsewhere on the island. The emphasis of surveys should be to search for solitary bats and additional bat colonies.

    b. Conduct monthly censuses at known bat colonies on Guam.

    c. Assist the CNMI Division of Fish and Wildlife (CNMIDFW) with surveys of fruit bats on other islands as needed.

2. Record information on the behavior and reproduction of fruit bats in colonies.

3. Determine habitat use of fruit bats. Visit abandoned roost colonies and record information about terrain and the size and abundance of vegetation present.

4. Monitor fruit bat imports to Guam from other islands in Micronesia and the Pacific.

5. Investigate illegal hunting of fruit bats on Guam.

    a. Visit abandoned roosting sites of colonies to determine illegal hunting effort.

    b. Assist Conservation Officers with investigations of bat poaching.

RESULTS

Locations of Bat Colonies on Guam

During FY90, colonies of fruit bats roosted at four known locations on Pati Point (Figure 1), each of which had been occupied for varying lengths of time in previous years. Roost 1, a favored site that has been used extensively in the past (DAWR 1987-1989), was inhabited for 7 months of the year (Table 1). Roost 20 was occupied from early June through the end of the reporting period, while Roosts 16 and 18 were each used for brief periods of about 1.5 to 2.5 weeks (Table 1).

Table 1. Approximate dates of use of four roost sites used by colonies of Marianas fruit bats on Guam in FY90.

Roost Number	Roost Location	Approximate periods of use by bats
1	North Pati Point	27 Oct 88-24 Oct 89, 10 Nov 89-26 May 90
16	East Pati Point	26 May -6 June 90
18	East Pati Point	24 Oct -10 Nov 89
20	East Pati Point	6 June 90-present

As in previous years, attempts were made to determine the reasons for colonies changing to roosts. Roost 1 was abandoned in late October on an estimated date that coincided with the passing of Tropical Storm Forest. It is possible that the storm's winds, which gusted to 80 kph, caused the bats to move from this site to a more protected location. Storms and other

unusual changes in wind direction are thought to have caused some past movements between roosts on Pati Point (DAWR 1988-1989). Illegal hunting was strongly suspected in the abandonment of Roost 18 on about 10 November (see Illegal Hunting). The colony at Roost 1 was apparently disturbed by me when shifting winds blew my scent toward it during observations on 26 May. The colony was found at Roost 16 five days later on the next date of observation. Roost 16 was abandoned on about 6 June for undetermined reasons. An inspection of the empty roost did not reveal any evidence of hunting.

Survey of Fruit Bats on Guam

Censuses of fruit bats at colonies varied substantially during the year, ranging from a high of 474 animals in January to a low of 199 animals in May (Table 2). The four colony counts from late January to April were believed to be complete censuses. These counts were made after Typhoon Koryn passed the island on 13-15 January and stripped the leaves from the *Ficus* trees used by the colony for roosting. Nearly all of the bats in the colony were believed to be visible during these censuses.

Table 2. Counts of Marianas fruit bats at roosts on Andersen AFB, Guam in FY90.

	Roost Number									
Date	1	14	15	16	17	18	19	20	21	Total
11 Oct 1989	320	0	0	0	0	0	0	0	0	320
3 Nov	0	-	0	0	-	+	0	0	0	x
17 Nov	+	-	0	0	-	-	0	0	0	x
20 Nov	362	0	-	-	-	-	-	-	-	362
2 Jan 1990	388	0	-	-	-	-	-	-	-	388
25 Jan	474	0	-	-	-	-	-	-	-	474
6 Mar	343	0	0	0	-	0	0	0	0	343
3 Apr	380	0	-	-	-	-	-	-	-	380
23 Apr	366	0	-	-	-	-	-	-	-	366
24 May	337	0	-	-	-	-	-	-	-	337
31 May	0	-	0	199	-	0	0	0	0	199
11 June	0	-	0	0	-	0	0	+	0	x
11 July	0	0	0	0	0	0	0	+	0	x
15 Aug	1	-	-	-	-	-	-	+	-	x
23 Aug	-	-	0	0	-	0	0	275	0	275
26 Sept	0	-	0	0	-	0	0	292	0	292

+ = Bats present at roost but no count made; - = colony was not visited; x = no total count made.

Variation in counts during the year may have resulted from inter-colonial movements between the main roost and other smaller undiscovered roosts on the island, or from inter-island movements between Guam and Rota. One search for additional bat colonies was conducted in October on Pati Point and elsewhere on AAFB but did not find any roosts. This search was not exhaustive and small colonies could have gone undiscovered. Detailed censuses of fruit bats were not conducted often enough on Rota during FY90 to detect changes in that island's bat population and verify movements.

An estimate of Guam's population of fruit bats at the end of FY90 was determined using the September count of 292 bats at Roost 20. Because some individuals were probably hidden by thick foliage during that count, the total number of adults in the colony was likely to be 10 to 20% higher than the actual number recorded. In addition, based on previous observations (DAWR 1985), approximately 65% of the adults in the colonies were harem females. An estimated 10% of these animals probably possessed unweaned young. These figures provide an estimate of 321 to 350 adults and 21 to 23 juveniles, or a total of 342 to 373 bats, on Pati Point in September 1990.

Incidental daytime sightings of single fruit bats were made during the year at Naval Facility (1 sighting), Northwest Field (3 sightings), the Conventional Weapons Storage Area on AAFB (2 sightings), Uruno Point (1 sighting), at NAVCAMS about 1 km south of Falcona Beach (1 sighting), Pajon Point (1 sighting), Tarague Beach (2 sightings), Radio Barrigada (1 sighting), and the Fonte River valley on the south side of Nimitz Hill (1 sighting). Nighttime sightings of bats occurred at Northwest Field (1 sighting), Uruno Point (1 sighting), the Tarague cliffline (2 sightings), and Pott's Junction (1 sighting of 3 bats). At a location about 1 km south of Pott's Junction, employees of the Hatsuho Golf Course found a live baby fruit bat early on the morning of 26 June 1990, indicating that it's mother had foraged in the area during the previous night.

Excluding bats residing in the colony at Pati Point, an estimated 25 to 50 fruit bats are still believed to live solitarily or in small groups along the island's northern cliffline that extends from Bijia Point to Iates Point. An additional 25 to 50 animals probably inhabit Naval Magazine and other forested areas in southern Guam. Based on these figures, Guam's island-wide population of fruit bats at the end of FY90 was estimated to contain 392 to 473 animals. This number is a slight reduction from the FY89 estimate of 425 to 510 animals (DAWR 1989).

Survey of Fruit Bats on Rota

The DAWR assisted the CNMIDFW with a survey of fruit bats on Rota from 26-30 March. Three bat colonies were found during the survey, but an accurate count of roosting bats was obtained at only one of these locations. The largest colony was found in area known as As Mundo at a site near the top of a steep hillside. A direct count of this colony was conducted from a nearby viewpoint (about 80-100 m away) and revealed 492 bats. An estimate of 550-600 animals was made for the colony. Departure counts on two evenings yielded similar estimates of 583 and 645 bats. At Saguapakpak and As Pupuenge, evening departure counts provided estimates of 45 and 25 bats, respectively, living in small colonies at these two sites. A loose, non-colonial aggregation of about 25 bats was also observed at Palii.

Solitary bats were surveyed during station counts around the island. An extrapolation of results gave an estimate of 91 extra-colonial animals island-wide. Based on all counts, a total population estimate of approximately 786 bats was made for Rota. Results from this count and several others made in 1989 suggest that the island's current population is about 800-1,000 bats (Stinson et al., in press).

Data on the incidence of harem females with young (see Natural History) were also gathered during this survey.

Natural History

Reproduction - During March, observations of harem females in colonies on Guam and Rota were made to look for the presence of unweaned young. This is a continuation of similar work performed in previous years (DAWR 1985-1989). Females with young comprised 16.2% of the females on Guam and 45.2% of the females on Rota (Table 3). All of the juveniles seen on Guam were small-sized. However, on Rota, the relative proportions of the size classes of juveniles were: small, 43%; medium, 43%; and large, 14%. These observations continue to illustrate the disparity in reproduction among bats on the two islands.

Table 3. Number of harem females observed with unweaned young at colonies on Guam and Rota in March, FY90.

	Total no. of females observed	No. of females without young	No. of females w/ small young	No. of females w/ medium young	No. of females w/ large young	% of females with young
Guam	105	88	17	0	0	16.2
Rota	31	17	6	6	2	45.2

A small (weight = 105 gr; forearm = 92 mm) male baby bat was turned into the DAWR on 26 June. It was estimated to be about 3 weeks old.

Activity Patterns - Observations on the activity patterns of day roosting fruit bats were made on Pati Point from 24 April to 1 June. Observations were conducted over the equivalent of four entire days from dawn to dusk. Seventy-six individuals were observed every 15 minutes. Their activity was categorized as one of the following behaviors: sleeping (wings closed, open, or fanning), awake (wings closed, open, or fanning), grooming, scratching, wing-head rubbing, urination or defecation, ambulation, courtship, harem defense, fighting or other forms of aggression, or other behaviors. These data have not yet been analyzed.

Illegal Hunting

Poaching has long been a major cause of mortality of *P. mariannus* on Guam and other islands in the southern Marianas (Wiles 1987a, 1987b; Wiles et al. 1989, Stinson et al., in press). One probable case of illegal hunting was recorded on Guam in FY90. An inspection of Roost 18, following its abandonment on about 10 November, revealed the decomposed carcass of one bat and the presence of several freshly broken tree branches. However, no expended ammunition was found at the site. This roost was located close to the end of the south runway on AAFB, and the colony would have been easily seen and heard from the runway's perimeter road.

Illegal hunting continued to plague the bat population on Rota in FY90, with a number of poaching incidents recorded (G. Witteman and R.E. Beck, pers. comm.). Poaching is undoubtedly responsible for the continued low numbers of bats on the island (Stinson et al., in press) and is likely to indirectly influence the numbers of bats in Guam's population.

Fruit Bat Imports

Major changes in the fruit bat trade occurred in FY90. In October, at the biennial CITES convention at Lausanne, Switzerland, seven species of Pacific island *Pteropus* were placed on Appendix I of CITES, with the remaining 48 species in the genus and all six species of *Acerodon* added to Appendix II. The U.S. Fish and Wildlife Service (USFWS) began enforcement of the new trade restrictions on 1 April by stationing a wildlife inspector on Guam. Two people held this position, with William Dusel working from April to mid-July and Herb Roche present from mid-July to mid-September.

A total of 49,987 fruit bats were requested for import during FY90 (Table 4), a decrease of 34.7% from the previous year (DAWR 1989). The number of import permits issued by the DAWR declined to 626 during the year, a drop of 29.2% from FY89. Demand, as measured by the volume of import requests, declined significantly after enforcement of the new CITES restrictions began. Requests totaled 37,641 bats on 468 permits issued during the first six months of the year but totaled only 12,346 bats on 158 permits after 1 April

(Table 4). Approximately 30.4% of all import permits issued by the DAWR during FY90 had fruit bats as one of the items requested.

An estimated 10,051 frozen fruit bats in 319 shipments were actually shipped to Guam from other islands in FY90 (Table 5). These figures represent a 39.7% decrease in the estimated number of imported bats and a 7.5% decrease in the number of shipments received when compared to FY89 (DAWR 1989). Trade was much reduced after 1 April when CITES restrictions began to be enforced. Only 1,622 bats in 72 shipments entered the island after this date (Table 5). The only legal shipments of bats to enter Guam after 1 April came from Palau.

Palau and Pohnpei were again the major sources of fruit bats for the Guam market in FY90, with exports of 5,309 and 4,294 animals, respectively, during the year (Table 5). These amounts were 95.5% of the total number of bats imported during the year. Chuuk, formerly known as Truk, shipped 389 bats to the island in FY90. No other island or country exported significant numbers of fruit bats to Guam during the year (Table 5).

During FY90, 676 fruit bats in 53 shipments were confiscated by the Guam Customs and Quarantine Division upon entry into Guam. These figures represented 6.7% of the total number of bats brought to the island and 16.6% of the shipments received during the year. Shipments were seized for a variety of violations including 1) lack of import permits or certificates of origin, 2) violation of the new CITES regulations, and 3) violation of local protective laws on the bats' islands of origin, thereby resulting in Lacey Act violations. Beginning in March, Guam Customs and the USFWS seized a number of shipments from Palau after determining that the bats had been killed with shotguns in violation of Palau firearm laws. The USFWS allowed three of these shipments, which contained a total of 125 bats, to be returned to Palau.

Manuscripts

Five manuscripts were written during the year. Three of these summarized statistics from the fruit bat trade and recent changes in the trade resulting from the implementation of new CITES restrictions. These articles will appear in the proceedings of a fruit bat conference held in Honolulu (to be published by the USFWS), in the proceedings of a National Parks Service conference held on Guam, and in *Bats*, a magazine published by Bat Conservation International. An article on the food plants and economic value of Pacific island *Pteropus* was also written for the proceedings of the Honolulu bat conference. Finally, species accounts were written for the six Micronesian species of *Pteropus* for the Megachiroptera Action Plan to be published by the IUCN.

Public Education

Lillian Mariano, the Public Information Officer of the DAWR, gave presentations at a number of schools during the year and displayed one of the Division's captive bats at many of her talks. Children always responded with immense interest and enthusiasm at the appearance of the bat.

Merlin Tuttle from Bat Conservation International and Dieter and Mary Plage from Survival Anglia Ltd. visited Guam from 10-19 December to film the island's fruit bats and their habitat. The DAWR assisted by escorting them to the bat colony on AAFB and to habitat devoid of bats on Naval Magazine. Survival Anglia Ltd. will produce several television programs on bats of the world in 1991.

Table 4. Numbers of frozen fruit bats requested for import to Guam from October 1, 1989 to September 30, 1990.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	No. of Permits Issued
Palau	1,975	2,790	5,140	2,170	1,570	4,050	3,347	2,012	1,427	2,731	1,214	915	29,341	433
Pohnpei	1,088	3,355	2,364	430	2,675	5,955							15,867	148
Chuuk (Truk)	410	1,512	350	625	112	130							3,139	32
Papua New Guinea					100			100	600				800	4
Indonesia					400								400	3
Kosrae			150	50									200	3
Philippines			200										200	1
Marshalls						40							40	2
TOTAL	3,473	7,657	8,204	3,275	4,857	10,175	3,347	2,112	2,027	2,731	1,214	915	49,987	626

Table 5. Numbers of frozen fruit bats imported to Guam from October 1, 1989 to September 30, 1990.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total*	No. of Shipments Received*	No. of Bats Confiscated	No. of Shipments Confiscated
Palau	348	852	959	375	395	816	856	183	108	170	148	99	5,309	223	414	33
Pohnpei	203	1,009	636	450	1,000	951	25		20				4,294	80	198	11
Chuuk (Truk)	90	81	75	112	22						9		389	8	31	3
Kosrae			26										26	2	0	0
Saipan	3				13	2							18	4	18	4
Yap			11							4			15	2	15	2
TOTAL	644	1,942	1,707	937	1,430	1,769	881	183	128	174	157	99	10,051	319	676	53

*Totals include confiscated bats.

The DAWR provided some assistance to Ms. Lili Sheeline, a graduate student from Yale University who visited Guam for 11 weeks from June to August. She interviewed approximately 200 Chamorro residents regarding their consumption of fruit bats and their overall attitudes toward the environment.

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually. Searches for additional colonies may be productive because continued poaching at bat roosts on Rota (G. Witteman, pers. comm.) can cause large numbers of bats to move to Guam (Wiles and Glass, in press).

2. Continue to make observations at Guam's bat colonies. Information on reproductive biology, behavior within the colonies, and social organization will be used to supplement data already gathered.

3. Summarize data previously collected and write reports on the diet, reproduction, and amount of snake predation on fruit bats.

4. Conduct a study of the vegetation, terrain, and proximity to development of known roosting sites to determine what site characteristics are important in the selection of roosting sites by fruit bat colonies.

5. Known bat roosting and foraging areas should be patrolled regularly by Conservation Officers. Part of their effort should be aimed at maintaining a visible presence at Jinapsan and Pajon Points, where poaching has been a serious problem in previous years.

6. Form a cooperative bat research program with the CNMI to collect information on the locations and sizes of colonies, reproductive biology and behavior within colonies. Most of the work done under this program would be conducted on Rota where a moderately sized bat population is found but where logistics prevent the CNMI from doing extensive fieldwork. Emphasis of this project would be to identify colonies should they move between Guam and Rota.

7. Continue to monitor fruit bat imports entering Guam. Export permits or certificates of origin should continue to be required for all shipments to ensure that the bats have been legally harvested, that the place of origin is known, and that the government authorities at the place of origin are aware of the drain on their fruit bat populations.

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Report prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-27
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 4

JOB TITLE: Roost Site Characteristics of Marianas Fruit Bats

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

No significant effort was expended on this job during this segment.

Report Prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-3
STUDY NO.: 4
JOB NO.: 2

JOB TITLE: Development of an Experimental Population of Guam Rails on Cocos Island or in the Commonwealth of the Northern Mariana Islands.

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

Activities and results consolidated under E-1-5, Study 4, Job 2.

Report prepared by: Robert Beck

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-4
STUDY NO.: 4
JOB NO.: 2

JOB TITLE: Development of an Experimental Population of Guam Rails on Cocos Island or in the Commonwealth of the Northern Mariana Islands.

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

Activities and results consolidated under E-1-5, Study 4, Job 2.

Report prepared by: Robert Beck

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-5
STUDY NO.: 4
JOB NO.: 2

JOB TITLE: Development of an Experimental Population of Guam Rails on Cocos Island or in the Commonwealth of the Northern Mariana Islands.

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

A final rule to establish an "Experimental Population" of Guam Rails from a captive-bred population was in the Federal Register in November 1990. A total of 22 Guam rails were released at the Sabana on Rota during three releases in December 1989 and February 1990. All but one were released with radio transmitters attached in order to monitor their dispersal, mortality and possible breeding success. Of the twenty-two released birds, the whereabouts of 9 are unknown as their radios failed, 4 were killed by vehicles, 2 were killed by cats, 2 apparently died of starvation, 1 may have died of poisoning, and 4 died of unknown causes. Planning is continuing for a second release of rails in FY91.

BACKGROUND

Since the creation in 1960 of the Guam Division of Aquatic and Wildlife Resources (DAWR), census data from roadside counts, station counts, and transect counts have documented the reduction in range and numbers of the Guam Rail, *Rallus owstoni,* and other native birds (DAWR 1961-1987; Jenkins 1983; Engbring and Ramsey 1984). Predation by the brown tree snake, *Boiga irregularis*, is believed to be the major factor contributing to recent declines in native bird populations (Savidge 1986, 1987; Conry 1988). Research efforts are presently underway to develop methods for controlling rail predation by the brown tree snake. However, it is not likely that we will be able to adequately control snake predation on Guam so that we will be able to introduce the rail back into the wild there in the near future.

A captive-breeding program for the Guam Rail was successfully begun in 1983 on Guam and at mainland U.S. zoos in cooperation with the American Association of Zoological Parks and Aquariums (DAWR 1984-1987; Derrickson 1986). Guam Rails were first brought into captivity in 1983 on Guam and bred at the DAWR's rail facility in the spring of 1984 (DAWR 1983-4). By September 1989 there were more than 150 rails in captivity on Guam and at stateside zoos.

The DAWR is developing plans to introduce the Guam Rail to Rota in order to develop a self-sustaining wild population of rails that will not undergo "domestication" from captive breeding. It is hoped that the experience gained in introducing the rails to Rota will provide valuable information useful for future introductions on Guam. The Rota population may also serve as a partial source of birds for use in reintroducing the rail to Guam when snake predation has been controlled there.

During FY87, a cooperative agreement was signed between the Government of Guam, Commonwealth of the Northern Mariana Islands (CNMI), and the U.S. Fish and Wildlife Service (USFWS) outlining the responsibilities of each entity for the introduction. An environmental assessment was prepared for the USFWS covering the introduction of the Guam Rail to Rota and forwarded to Environmental Services, USFWS, Honolulu. Upon, review, it was mutually decided to additionally conduct an insect and reptile survey of Rota to discover the presence of possible endangered species. Dr. Stuart Pimm, Professor of Zoology, University of Tennessee, and the DAWR reached an informal agreement by which a graduate student from the University of Tennessee would reside on Rota for at least three years to monitor the rail introduction in cooperation with the DAWR, as a part of his dissertation research. In addition, Dr. Pimm, with the support of the DAWR, applied for research grants to support the monitoring study. In April, 1987 staff from the DAWR and Dr. Pimm, accompanied by staff from the CNMI Fish and Wildlife Division, visited Rota to investigate possible sites for the introduction. Sites in Palii and Sinapolo were tentatively selected. In addition, visits were made to various Rota government officials to update them as to the status of the project.

During FY88, the captive breeding of the Guam Rail continued at the DAWR captive breeding facility and mainland U.S. zoos with the captive population now numbering over 120 rails. Contracts for construction of 22 additional rail breeding aviaries on Guam were let and construction began.

A survey of Rota for reptiles was conducted by staff from DAWR and the USFWS in the fall of 1987. Staff of the University of Guam conducted an insect survey of Rota in February 1988. The results of both surveys, which found no endangered species, were submitted to the USFWS, Honolulu for inclusion in the Environmental Assessment for the project.

In May 1988, the Curator of Birds and the National Zoological Park, Dr. S. Derrickson, and staff of DAWR visited Rota to search for additional possible introduction sites. A site on the Sabanna was selected for the initial introduction. Dr. Derrickson also transported rails to Guam to broaden the genetic variation of the Guam captive population in preparation for breeding birds for release on Rota.

In June 1988, staff of the DAWR, with the assistance of the Rota Department of Natural Resources, constructed three 12-stall holding aviaries at the Sabana introduction site.

Radio telemetry equipment to be used to monitor the success of the introduction was purchased by the DAWR.

The University of Tennessee cooperator was successful in receiving several grants from international conservation organizations to support his efforts in monitoring the introduction on Rota with the graduate. Using these funds, a 1/2 ton pickup truck was purchased on Rota for use by the staff monitoring the introduction.

In July, 1989 we were informed by the U.S. Fish and Wildlife Service that there would be a delay in publication of the Final Rule required for designating the "Experimental Population" status of the rails released on Rota a situation which would delay the introduction into FY90.

Conservation organizations were notified of the delay so that coordination of their funding could be arranged to not cause delay of implementation of the monitoring project. The final rule was published in the Federal Register in November 1990.

PROCEDURES

1. Finalize permits required for the introduction from the Commonwealth of the Northern Mariana Islands and the U.S. Fish and Wildlife Service.

2. Captive breed Guam Rails needed for the introduction on Guam and at mainland U.S. zoos.

3. Continue to develop techniques and methods for introduction of the rail to Rota.

4. Implement disease prevention protocol with rails on Guam prior to release on Rota.

5. In cooperation with Dr. Stuart Pimm and Gregory Witteman, Department of Zoology, University of Tennessee, monitor the success of the initial introduction of Guam Rails to Rota and continue with successive introductions to the island as warranted.

6. Continue to seek funding from conservation organizations to support the monitoring of the introduced rail population on Rota.

RESULTS

Six Guam rails were released on Rota in December 1989. The purpose of this initial release was to test methods and location. All birds flown to Rota for the release were held for two days at the rail holding facility at the release site. During this time they were weighed and measured and all individuals had color leg bands and harness-mounted radio transmitters attached. The transmitters were of both solar and battery types and weighed between 4% and 7% of the rails' body weight. The rails were fed a reduced portion of the feed used in the Guam captive breeding facility, and a supplement of live-caught insects. This supplemental feeding began on Guam, and was intended to enhance the foraging abilities of the rails after release into the wild.

Two individuals from this release established well-defined foraging ranges of approximately 1ha in size, 100 and 400 meters from the release site. Of the other four birds, one lost its radio (600m from the release site), two had radio failures within two weeks of release (last observed 200 and 350 meters from the release site), and one was found dead (80m from the release site). Rail droppings were consistently found for all but one of the rails, which suggests that the rails were foraging successfully in the area. Of the two rails that remained within well-defined ranges, one was run over by a vehicle after two months, and the other shed its transmitter in less than three months. From this initial release 4 are known dead and because of radio failure, the status of the remaining two is unknown.

The initial movements of the rails seem to suggest that they had little or no site fidelity to the release area. It was clear that use of radio transmitters on the radios is critical in ascertaining their disposition; there were only two confirmed sightings of rails later than one week after the release, and none of the mortality would have been known without their use.

Incorporating the observation that released individuals seemed to have little or no "site-fidelity", the second release was designed as a set of multiple small "sub-releases" that left a number of individuals in the temporary holding cages. We hoped that vocalizations by the rails in the cages would attract or induce the released rails to remain in the area. The time between sub-releases was minimized in order to simulate one large release rather than several smaller unrelated ones.

S. Dillon Ripley, Secretary Emeritus of the Smithsonian Institution and early supporter of the captive breeding effort, released the first of these rails on February 2nd, with subsequent releases on the 5th and 7th. Of the 16 birds that were released 11 are known dead. Due to radio failure, the status of the remaining 5 is presently unknown. Three individuals remained within 50m of the holding cages. Two of these individuals were eventually found dead, and one rail is thought to have died from rat poisoning. Other confirmed sources of mortality for this release included: feral-cat predation (3), vehicular mortality (3), and pig trampling (1) (Figure 1).

Date Released	Stud-book	Metal Band	Left Band	Right Band	Sex	Status	Notes/ last date observed	Cause
12/9/89	37	786	RB	R/M	M	Dead	"Road kill"/tractor- 2/6/90	Road Kill
12/9/89	74	1070	R/M	RY	F	Dead	Unkn cause-decomp- 12/28/89	?
12/9/89	158	840	BY	R/M	M	Missing	Bad Radio? Last contact- 12/24/89	no Radio
12/9/89	160	10169	R/M	BR	F	Missing	Bad Radio? Last contact- 12/15/89	
12/9/89	164	846	YB	R/M	M	Missing	Found radio in natural pit 12/31/89	no Radio
12/9/89	195	855	YR	R/M	F	Missing	Found radio/no bird, 3/3/90	no Radio
1/29/90	181	10186	M		M	Missing	Accidentially released without radio.	no Radio
2/1/90	30	809	YM	YR	M	Dead	Found dead- road kill ?? -2/10/90	Road Kill
2/1/90	129	1090	YG	YM	M	Dead	Dead-aviary, harness 1/31/90	?
2/1/90	153	843	RY	MR	M	Dead	2/15/90, Center Sabana taro patch	Killed by Cat
2/1/90	157	839	MY	RY	F	Missing	Last contact 3/8/1990	
2/1/90	159	841	YR	MY	F	Dead	near center sabana taro patch/2/15	Poison?
2/1/90	162	844	RY	MR	M	Dead	Road Kill, 2/14/90	Road Kill
2/1/90	163	845	YR	MR	F	Dead	Bird found 3/3, decomposed	Road Kill
2/4/90	90	785	RY	MY	M	Dead	found dead< 10m from cages 2/7/90	?
2/4/90	106	733	BB	M	F	Missing	2/6/90, possible radio failure	
2/4/90	131	1095	MR	RY	F	Dead	Found decayed (>1wk) 2/20/90	?
2/4/90	150	10179	RR	MR	M	Missing	Last contact 2/9/1990	
2/4/90	175	1183	RY	MY	F	Dead	died of starvation 2/7/90	?
2/7/90	71	830	MB	GR	F	Dead	2/16/90, killed by a cat	Killed by Cat
2/7/90	130	1094	MB	YB	F	Missing	Last contact 2/12/1990	
2/7/90	182	10187	BY	MB	M	Dead	2/15/90 in pig pen	Killed by Pig
To Guam 2/8/90	119	1091	YR	BM	M	To Guam	Lost aprox 34g while in cage	
To Guam 2/8/90	60	823	BY	MB	M	To Guam	Mate of above-male.	
To Guam 2/8/90	147	221		M	F	To Guam	Bad radio, bird possibly weak	
To Guam 2/8/90	61	1067	MB	YR	F	To Guam	Eye problem/weak-mate below.	

Figure 1: Results of the December 1989 and February 1990 Guam Rail releases on Rota.

During March, radio transmitters were attached to a breeding pair of Guam Rails at the captive breeding facility to see if the radio transmitters necessarily interfere with successful breeding. The female of the pair to which the radios were attached was regularly laying eggs before the attachment, and continued to do so after. The clutch produced after radio attachment successfully produced chicks. Although this does not prove that the radio transmitters do not affect the rails in other aspects, it does show that they do not prohibit successful breeding.

During May and June, an extensive search for the remaining rails was conducted using both tape playback and radio receivers. No additional rails were detected.

The following points, based on the results of the December 1989 and February 1990 releases, have been considered in the decision to change the release site, radio tagging, and propagule size of the next release (January 1991):

Location

a) There seems to be no site fidelity of released birds to the current release site.

b) Ground cover was much denser than originally thought when the site was chosen.

c) Current golf course plans and surveys have included the study area in their development.

d) Mortality: Road kills (and hence traffic) and feral cat predation in the area were high and may be less at an alternative site (Saguagaga).

e) If rails were still in the original release area, there would be advantages of conducting subsequent releases in the same area. Currently, no rails have been recently detected in the original release area, therefore, a move to a new release location would not be "abandoning" surviving rails.

Transmitters

There seems to be no indication that the transmitters were responsible for mortality. Rails that were released with either no transmitter, or who shed their transmitter, were never detected through visual observation or call playback. For this reason, it is critical that radio tagging of at least a portion of the rails be continued. Without it, it is unlikely that rails would ever be detected after the release and we would have no information on the status of our wild population. In the January 1991 release, all males in the release propagule will be fitted with radio transmitters. This would let us track all possible pairs (male/female) and not affect the female's breeding activity.

Release Propagule Size

Clearly, serial releases of six individuals while rails were held in the area were not successful in enhancing site fidelity. Both, evidence from previous avian releases and theory, suggest that the release propagule should be much larger. For this reason, we are targeting our January 1991 release at between 40 and 50 individuals.

RECOMMENDATIONS

1. Continue releases on Rota. Use alternate site and methods described above, evaluate results and change strategy as necessary.

2. Captive breed Guam Rails needed for the introduction on Guam and at mainland U.S. zoos.

3. Implement disease prevention protocol with rails on Guam prior to release on Rota.

4. Continue to monitor the success of the future introductions of Guam Rails to Rota.

5. Continue to seek funding from conservation organizations to support the monitoring of the introduced rail population.

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Report prepared by: Gregory J. Witteman and Robert E. Beck, Jr.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: E-1-5
STUDY NO: 7
JOB NO: 1

JOB TITLE: Biology of the Brown Tree Snake

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

Studies on the impact of the Brown Tree Snake, *Boiga irregularis*, on Guam's fauna and on the ecology and biology of the snake are in progress.

Information gathered from various sources on Guam indicates that areola effects in a number of population parameters are discernable. All these areola effects point towards populations being highly reflective of local conditions, particularly prey base.

Effects on humans continue to be significant. Bites by the Brown Tree Snake appear to be concentrated on sleeping children less than six years old. The majority of bites occur during the wet season (May through November).

Biological profiles of the ubiquitous prey base (lizards) continue. Information that has been gathered includes reproductive cycling, movements, growth, and habitats.

BACKGROUND

Data indicate that *B. irregularis* has been responsible for the demise of the most of the native forest dwelling avifauna (Savidge, 1987) of Guam. Additionally, at least two species of lizards (*Gehyra oceanica* and *Perochirus ateles*) probably suffered the same fate. Enormous economic damage in terms of power outages has also been documented (Fritts, et. al., 1987).

OBJECTIVES

In order to control and contain *B. irregularis* populations on Guam, an intimate knowledge of populations must be gained. These objectives must also include significant insights into the population biology of their most ubiquitous prey base (lizards).

PROCEDURES

1. Collect and analyze snakes from various localities on Guam.

2. Collect and analyze lizards from various localities on Guam.

RESULTS

Snake Contest

From 28 June to 23 July 1990, a privately sponsored snake roundup was held. Snakes were turned in at designated check stations three times per week and were then turned over to DAWR for additional analyses. Information collected by DAWR personnel included snout-vent length (SVL), sex, and locality. This data provided a unique opportunity to examine large numbers of snakes from Guam that were collected in a short period of time. Because of the nature of the contest, certain snakes were excluded from these analyses: those beheaded or severely damaged and those with questionable locality data. A total of 1275 snakes were turned in and of those, 1138 were used for analyses. Most (952) were collected from six identifiable localities (Fig. 1). The balance were from a number of other sites, but small sample sizes precluded them from all analyses except the island-wide analysis.

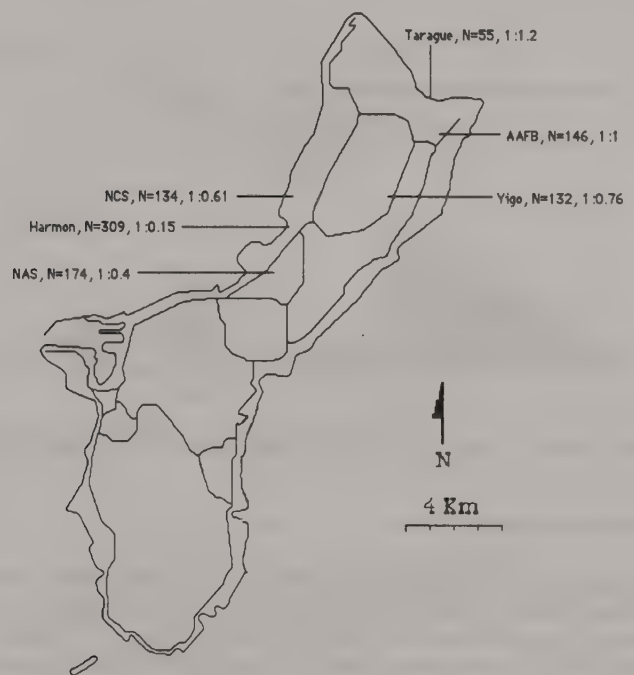

Figure 1. Data analyses sites from snake contest that includes: Site; Sample Size; and Male : Female Ratio.

Island-Wide Results

Analysis of all snakes collected in the contest (males (Fig. 2) and females (Fig. 3)) indicate that the phenomenon of an overall skewed sex ratio in favor of males (McCoid, 1988; 1989) continues on Guam. The ratio is 1 male : 0.52 females. This trend occurs in all size classes but becomes most pronounced in snakes greater than 1100 mm SVL. Interestingly, two large females collected in this contest are the largest on record for Guam.

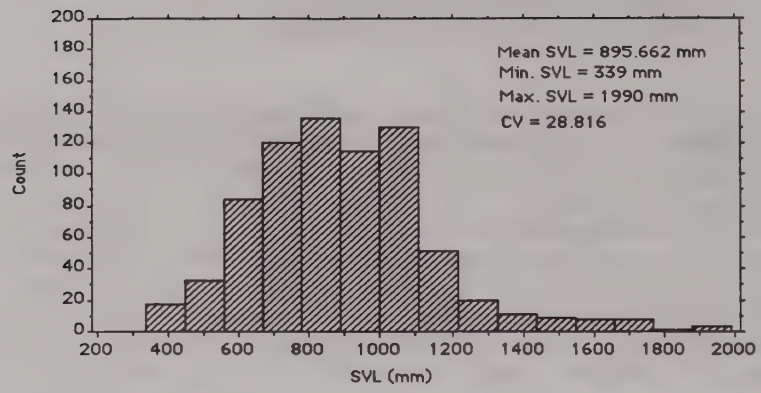

Figure 2. Size class distribution of male *B. irregularis* from Guam, collected between 28 June and 23 July 1990. N = 746.

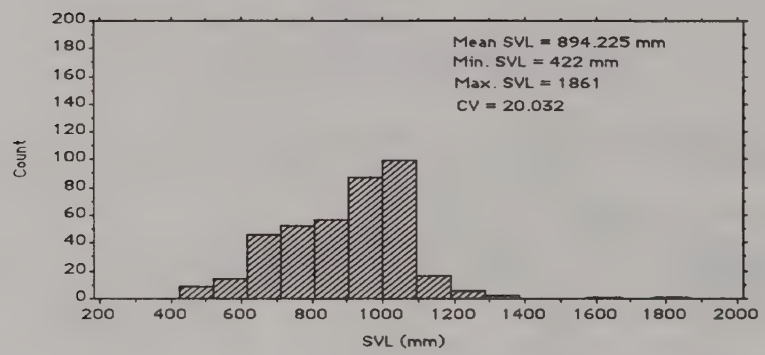

Figure 3. Size class distribution of female *B. irregularis* from Guam, collected between 28 June and 23 July 1990. N = 392.

Site Specific Phenomena

The northernmost site from which sufficient numbers of snakes were collected for analysis was the Tarague Beach area. Mean SVL for males (Fig. 4) and females (Fig. 5) were very similar. The second site was Andersen Air Force Base (AAFB). Mean SVL for males (Fig. 6) and females (Fig. 7) were also relatively close. The third site was in the area of the village of Yigo. Mean SVL for males (Fig. 8) and females (Fig. 9) were similar. The fourth site was Naval Communications Station (NCS). Mean SVL for males (Fig. 10) was slightly higher than females (Fig. 11). The fifth site was the Harmon cliffline. Mean SVL for males (Fig. 12) was similar to females (Fig. 13). The last site was the Naval Air Station (NAS) cliffline. Mean SVL for males (Fig. 14) was less than that of females (Fig. 15). Total numbers of snakes and sex ratios for all six sites are presented in Fig. 1.

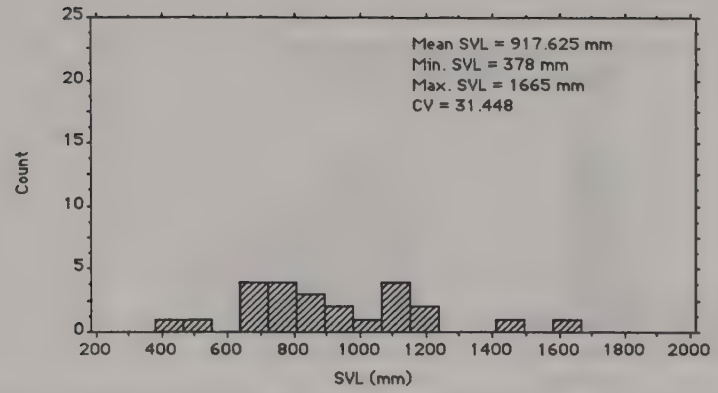

Figure 4. Male *B. irregularis* from Tarague, Guam. N = 24.

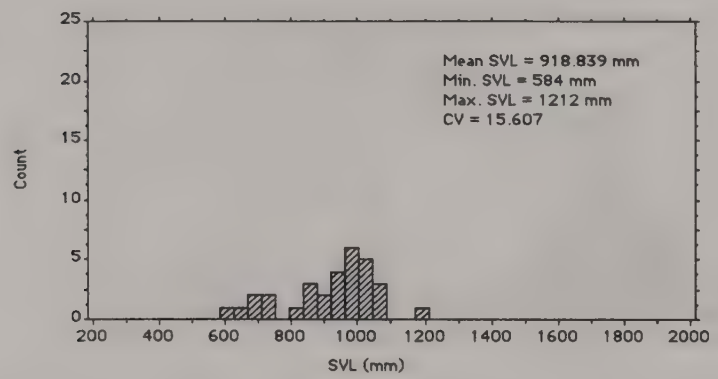

Figure 5. Female *B. irregularis* from Tarague, Guam. N = 31.

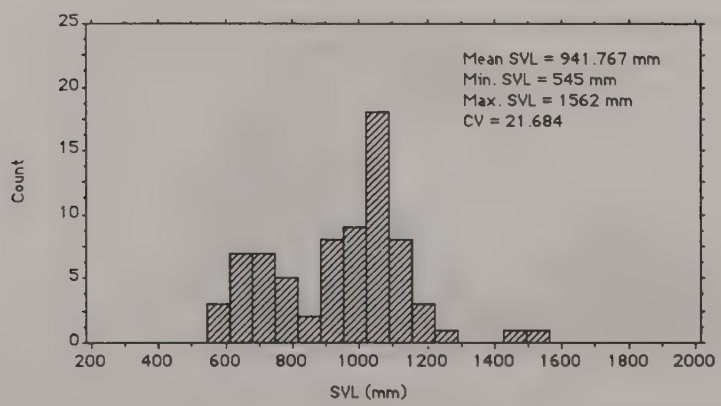

Figure 6. Male *B. irregularis* from AAFB, Guam. N = 73.

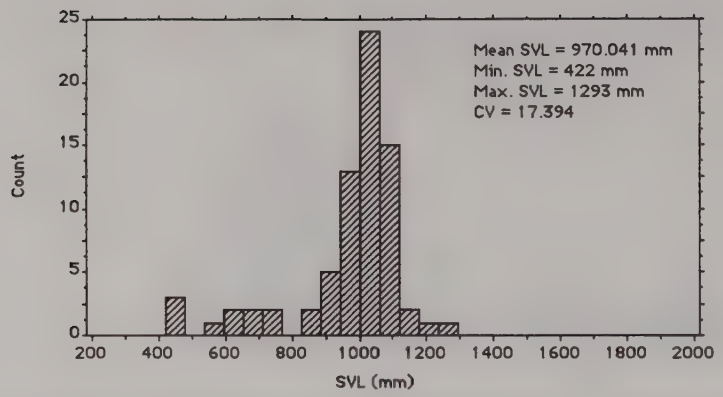

Figure 7. Female *B. irregularis* from AAFB, Guam. N = 73.

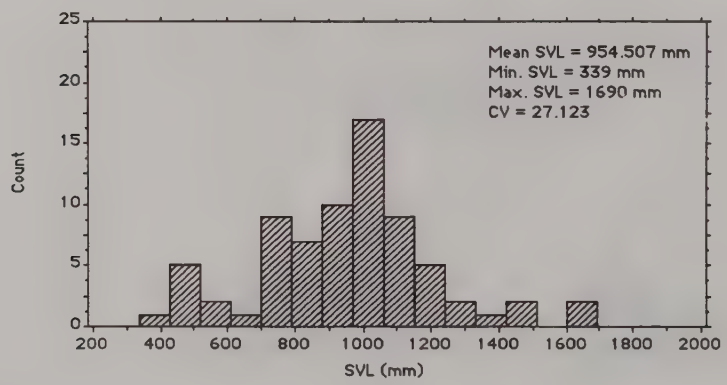

Figure 8. Male *B. irregularis* from Yigo, Guam. N = 73.

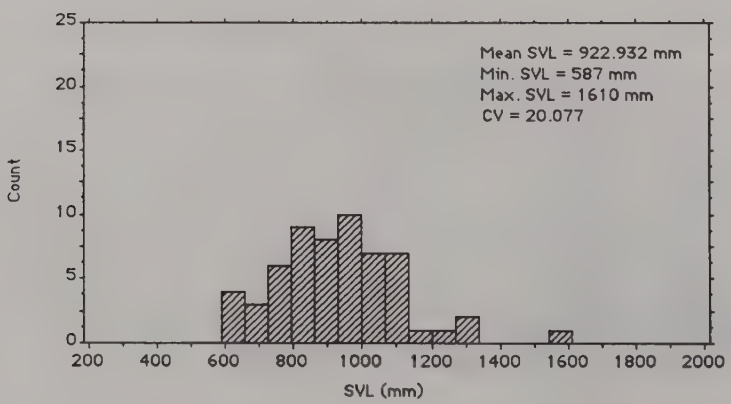

Figure 9. Female *B. irregularis* from Yigo, Guam. N = 59.

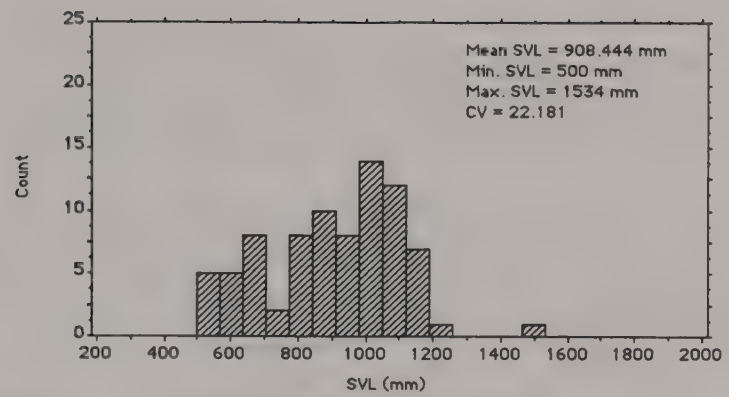

Figure 10. Male *B. irregularis* from NCS, Guam. N = 81.

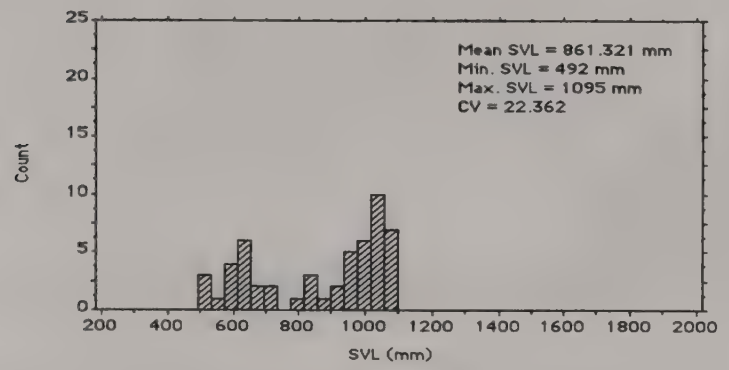

Figure 11. Female *B. irregularis* from NCS, Guam. N = 53.

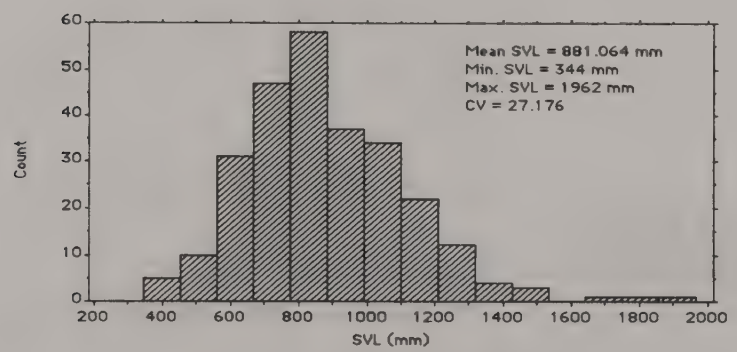

Figure 12. Male *B. irregularis* from Harmon, Guam. N = 266.

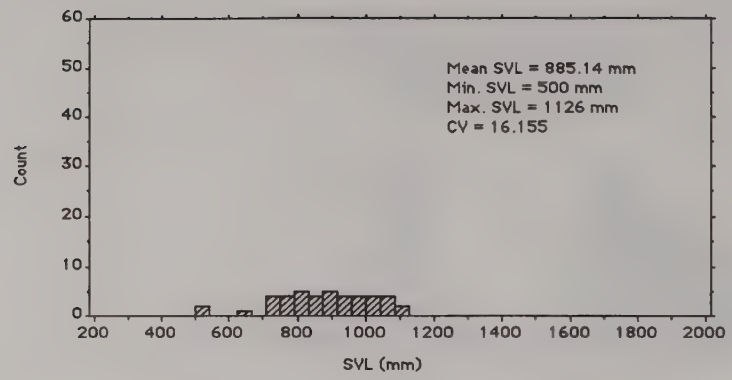

Figure 13. Female *B. irregularis* from Harmon, Guam. N = 43.

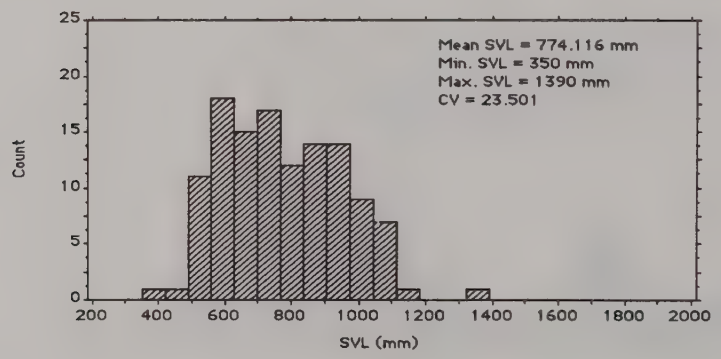

Figure 14. Male *B. irregularis* from NAS, Guam. N = 121.

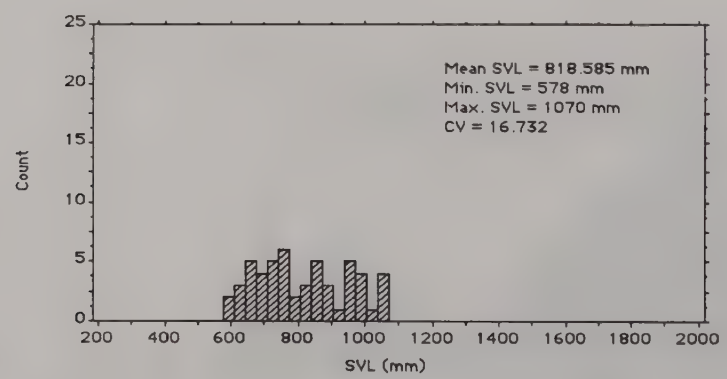

Figure 15. Female *B. irregularis* from NAS, Guam. N = 53.

Population Structure

From an island-wide viewpoint, males have a more normal distribution of size classes than females (Figs. 2 and 3). Females have a skewed size class distribution as a result of the paucity of individuals over 1100 mm SVL. This is also reflected in the Coefficients of Variation (CV) in that males are more variable with respect to SVL and have a higher CV.

Dissection of this island-wide population into relatively discrete sub-populations reveals areal differences. The Tarague site (Figs. 4 and 5) exhibits a high CV for males and a much lower CV for females. Females have a modal SVL around 1000 mm SVL, the size at initial reproduction (DAWR, unpub. data). The AAFB site (Figs. 6 and 7) shows relatively low CV's for both sexes and both sexes are modally distributed between 1000 and 1100 mm SVL, approximately the size at initial reproduction. Male SVL's are more variable at the Yigo site (Figs. 8 and 9) but are modally distributed at about 1000 mm SVL. Females are more normally distributed with the bulk of the population less than 1000 mm SVL, or not sexually mature. The NCS site shows equal variability for both sexes (Figs. 10 and 11) and both sexes have significant segments of their population at or greater than 1000 mm SVL. Of note, is that both sexes at this site exhibit what may be a cohort between 500 and 700 mm SVL. The Harmon site male snakes were considerably more variable than females (Figs. 12 and 13). This is attributable to the rarity of females at this site. The bulk of the males were less than 1000 mm SVL and not sexually mature. The last site is NAS and males were also more variable than females (Figs. 14 and 15). This is also probably attributable to the relative rarity of females. Based on SVL age structure, the majority of males and females at NAS were not sexually mature.

Sex Ratios

Sex ratios for the six sites are presented in Fig. 1. Sex ratios increase in favor of males in a roughly north to south direction. Presented in a different way, the percentage of adult females (greater than 1000 mm SVL) for each of the six sites mirrors this trend (Fig. 16).

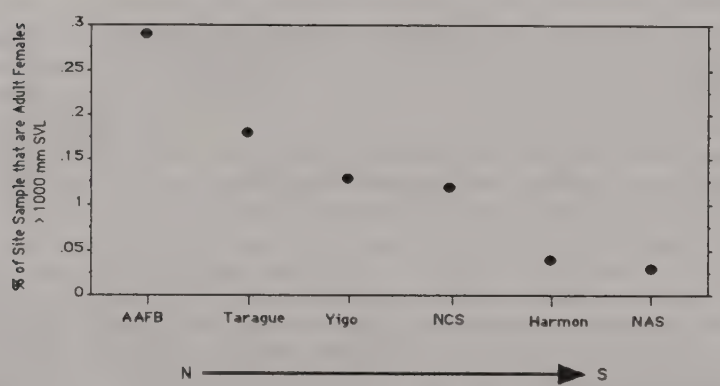

Figure 16. Percentage of female *B. irregularis* by Site.

Discussion

The significance of these phenomena is obscure, but they may be related to cyclic local population expansions and contractions that are characteristic of Guam populations (T. Fritts, pers. comm.). There may be some predictive attributes that can be extracted from the above data. In addition to the sex ratio shifts, mean size of both males and females

decreases roughly from north to south. Considering these trends in tandem (SVL and sex ratios) suggests that the more northerly populations (snakes are close to or at reproductive maturity) will be or are undergoing an expansion phase. Southern populations, because of decidely smaller SVL, have probably already gone through a population expansion. Thus, if the threat of cargo or aircraft infestation is related to *B. irregularis* densities, then it is possible that this pressure should decrease or remain at the current level for NAS (and Won Pat International Airport) and should increase at AAFB.

Because snakes at NAS and Harmon are younger on the average (based on SVL) than the northern sites, the rarity of females at these southern sites in the less than 800 mm SVL classes suggests one of the following: differential mortality of hatchlings/juveniles, behavioral differences for juvenile snakes, environmental or maternal sex determination, or differential sexual mortality of eggs. The first suggestion is unlikely as it implies that males and females have different nutritional or environmental requirements as juveniles. Savidge (1988) found no sexual differences in feeding habits and other investigators have not noted any environmental differences. The second suggestion is equally unlikely as no behavioral differences have been noted by many investigators. The last two suggestions are intriguing and have been observed in other species of snakes. Dunlap and Lang (1990) found that as maternal size (= age) increased in *Thamnophis sirtalis*, clutches shifted from female dominated to male dominated neonates. Burger and Zappalorti (1988) showed that in *Pituophis melanoleucus*, sex ratios of clutches could be manipulated by incubation temperatures. At low temperatures, male mortality increased and at high temperatures female mortality increased. Similar results were presented by Bull (1980) who found that incubation temperatures affected sex ratios of clutches during development in *Nerodia fasciata*. However, low incubation temperature yielded predominantly male biased broods and high incubation temperature yielded female biased broods.

Unfortunately, data on egg and neonate ecology of *Boiga* on Guam is essentially lacking. Data from a recently acquired clutch may hint at the solution but will be addressed below.

Feeding and Fat Cycles

Because most of the snakes collected in the contest were held between one and three days before being turned in and were dead, all specimens were discarded after data collection. Aspects of the biology of *Boiga* on Guam still remain unanswered (e.g. feeding in relation to fat cycles and areal effects). Snakes have been continually collected and necropsied to address these unanswered pieces of the *Boiga* puzzle. Four sites were selected with sufficient sample size to explore possible trends or patterns. These were Tarague Beach, Pati Point (AAFB), NAS, and a Pauliluc River site in southern Guam.

Stomach Analysis

Results of necropsies of 149 snakes from four sites with adequate sample size are presented in Fig. 17. The Pauliluc site is considered urban as human residents are involved in breeding and raising domesticated fowl and small mammals. The other three sites are non-urban and have few resident endotherm prey present. It is important to realize that at all four sites, introduced prey species form the majority of items ingested. This is not surprising in light of the virtual absence of native endotherms but is important when considering the ectotherm prey (*Carlia*, *Hemidactylus*, and *Anolis* are all introduced lizards). Thus, essentially the entire predator/prey relationship on Guam involving *Boiga* is an artificial system.

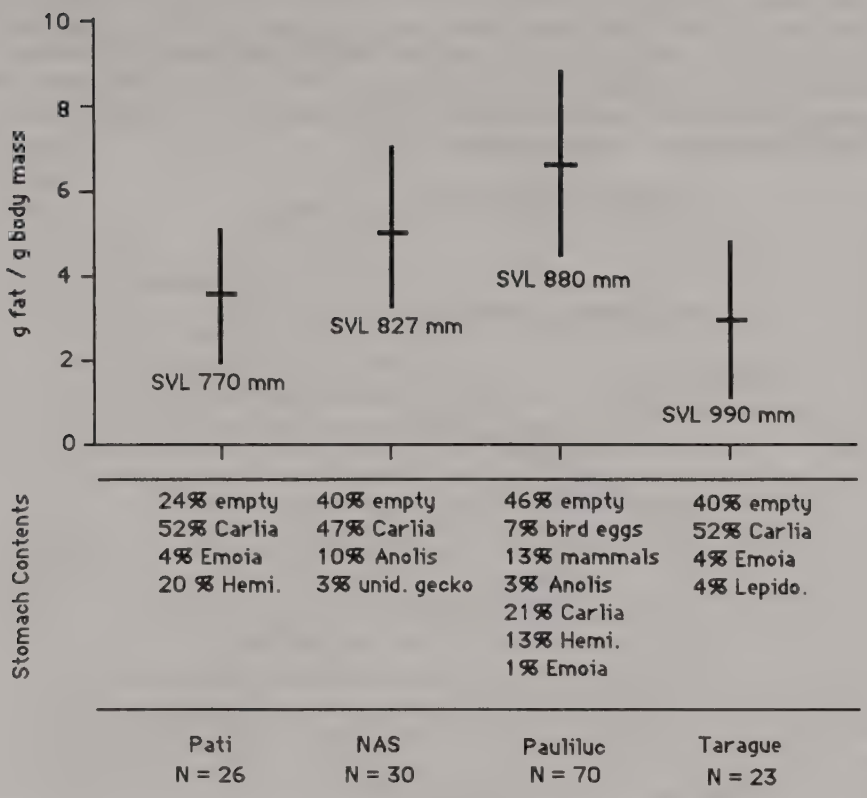

Figure 17. Stomach contents and relative fat weights for *B. irregularis* from selected sites. Horizontal bar is mean g fat/g body mass expressed as a percentage for each site. Vertical bar is plus or minus one standard deviation. Number associated with each bar is mean SVL for snakes from that site. Stomach contents are expressed as a percentage occurrence.

Fat Cycles

Results, by site, are also presented in Fig. 17. The trend that emerges is one of increasing fat per unit body mass with increasing SVL. The highest being the urban site with endotherm prey (Pauliluc). The lowest fat per unit body mass was Tarague. However, this site had the largest mean SVL. Greene (1989) suggested that *B. irregularis* should make a prey shift from ectotherms to endotherms at about 800 to 900 mm SVL. It may be that the Tarague site is less than optimal for that population from a prey base standpoint and that fat masses are reflective of this inability to undergo a prey shift. The mean SVL at Tarague is close to the initiation of sexual maturation. At that size, fat reserves would be mobilized for reproductive efforts, perhaps accounting for the decline in relative fat weights.

Reproduction

Insight can be gained into the relationship between prey availability and reproduction by comparing reproductive information collected in 1985 with that collected in 1989-90. In 1985, populations of now extirpated native birds were still present. By 1989, these

populations no longer occurred on Guam. Fig. 18 graphically shows a shift in follicle number. All data points on the 1989-90 graph fall on or below the regression line calculated for the 1985 data. This clearly shows that the number of follicles ovulated for a given size female is less now than in 1985. Another way of interpreting this is 66% of the females between 700 and 800 mm SVL had ovulated in 1985 and only 35% had in 1989-90. It appears likely that the decline in the number of endotherms available as prey has affected the follicular output of *Boiga* on Guam.

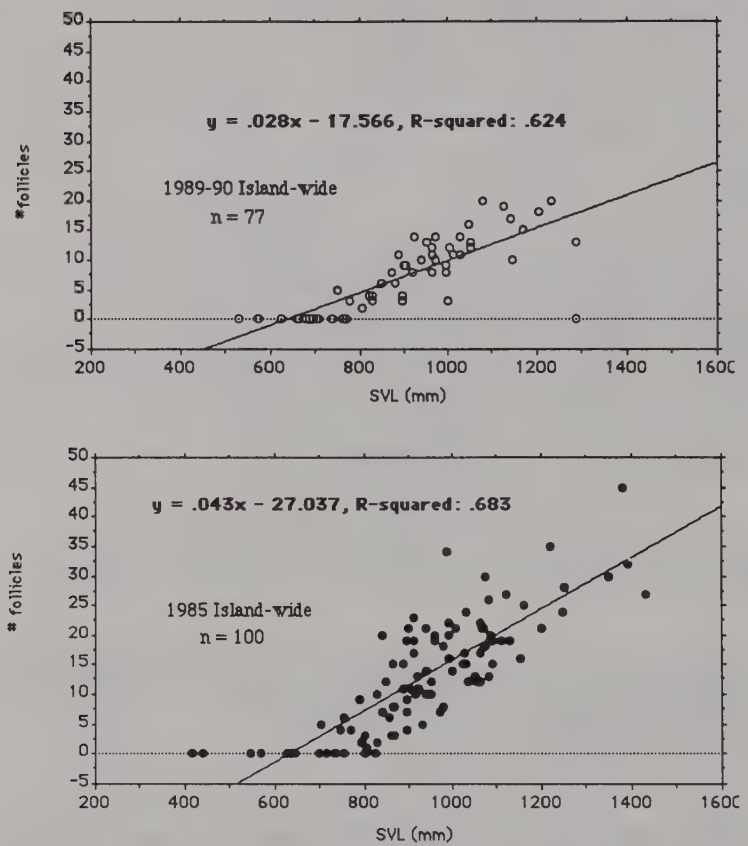

Figure 18. Follicle number versus SVL for 1989-90 island-wide (upper) and 1985 (lower) snakes.

Comparison of 1989-90 *Boiga* from Pauliluc with the rest of the island is less clear (Fig. 19). However, the Coefficient of Determination (R-squared) is much higher for the Pauliluc population indicating that size accounts for much of the variation in follicle number. This is not the case for the rest of the island but it should be noted that urban vs. non-urban situations were not identified in this plot. However, both high and low outliers are present, perhaps indicating fluctuations in prey availability.

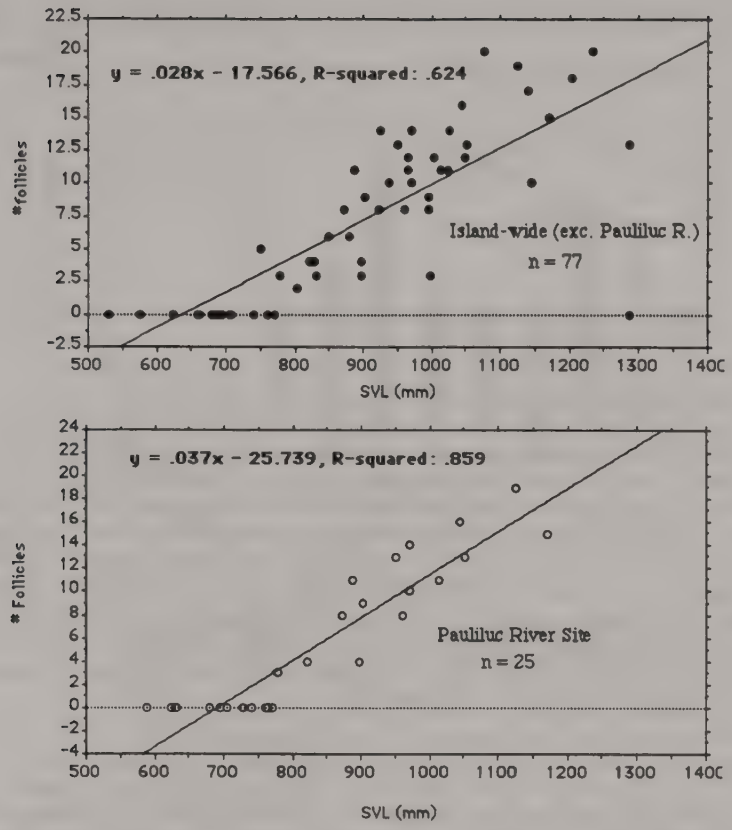

Figure 19. Number of follicles versus SVL of the Pauliluc Site (lower) and island-wide (upper) for 1989-90.

Zwinenberg (1978) indicated that *B. irregularis* lays between four and 12 eggs. Data collected from 1984 to the present indicate that this is the case on Guam (Fig. 20) and that the number of eggs deposited is highly related to maternal SVL. Perhaps the most surprising aspect is that of approximately 500 females necropsied since 1984, only 22 had enlarged yolked follicles or oviductal eggs. There are at least three explanations:

(1) Not all appropriately sized females reproduce. This is unlikely considering the enormous numbers of *Boiga* on Guam.

(2) Females yolking eggs display reduced foraging behaviors and are less likely to be captured. Possibly, but thousands of hours of fieldwork by many investigators have failed to yield many gravid snakes.

(3) The cycling time between initiation of yolking and egg deposition is relatively rapid. This is the most parsimonious explanation as it requires the least ad hoc assumptions but no data exist to support it.

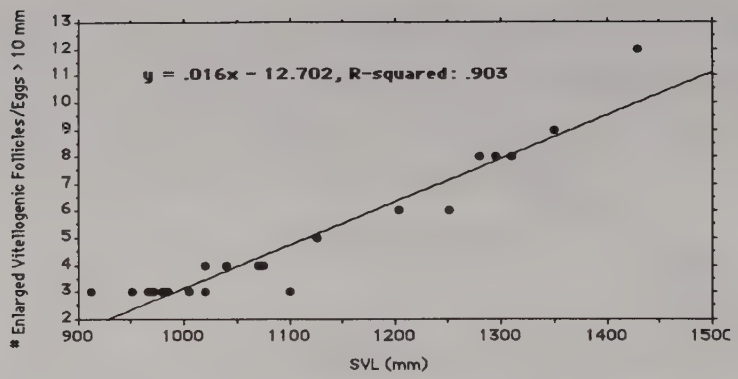

Figure 20. Reproductive output of *B. irregularis* on Guam.

On 6 July 1990 a clutch of eight eggs eight was received from a rancher in the Pagat area. The female (SVL 1295 mm) accompanied the eggs and deposition supposedly occurred, four to nine hours earlier. The eggs were incubated at ambient temperatures and the first snake hatched 9 October 1990. This represents an incubation period of 94 days. One egg was preserved on 24 July 1990 after it went bad. All other eggs were opened on 10 October 1990 and all embryos were full-term but dead. Mean SVL of embryos and one hatchling was 272 mm. Mean mass was 5.29 g. Shine (1989) reported on two clutches from Australia and the Pagat SVL range overlaps one of the them. However, mean mass was less than both the Australian clutches. Sex of all the Pagat embryos was female. Incubation time for the Australian clutches was 76 and 90 days.

Age and Growth

No attempts have been made to age snakes collected on Guam by DAWR personnel. However, techniques recently developed by J. Castanet (Laboratoire Evolution Etres Organises, Paris) involving verification and validation of growth rings in certain bones in relation to age should allow the determination of age and growth. Because of this, skeletonal preparations of *B. irregularis* are being made. To date, 134 have been processed. Analyses of these and future skeletal preparations will solve many of the questions regarding growth with respect to areal effects.

Human Impacts

The impacts that *B. irregularis* has had on Guam's human residents are well known. Fritts, et al. (1987) demonstrated that many power outages were caused by nocturnal activity of the Brown Tree Snake. Fritts and McCoid (1990) discussed the agricultural impacts and Fritts, et al. (1990) warned about the medical effects of bites, particularly for infants.

During the past year, a snake bite questionnaire was prepared by DAWR, Guam Public Health and Social Services, and the U. S. Fish and Wildlife Service for distribution to medical facilities on Guam. These questionnaires were constructed to collect information on the age and sex of the bite victim, location of the bite, activity at the time of the bite, date and time of the bite, and symptoms. These data allowed a more precise evaluation of the threat of *B. irregularis* bites on Guam.

In order to broaden the database and properly elucidate seasonal trends, data from September 1986 through August 1990 were combined (Fig. 21). The pattern that emerges

is one of increased bites being reported during the wet season (May through November). This pattern resembles that presented by Fritts, et al. (1987) for snake-related electrical outages.

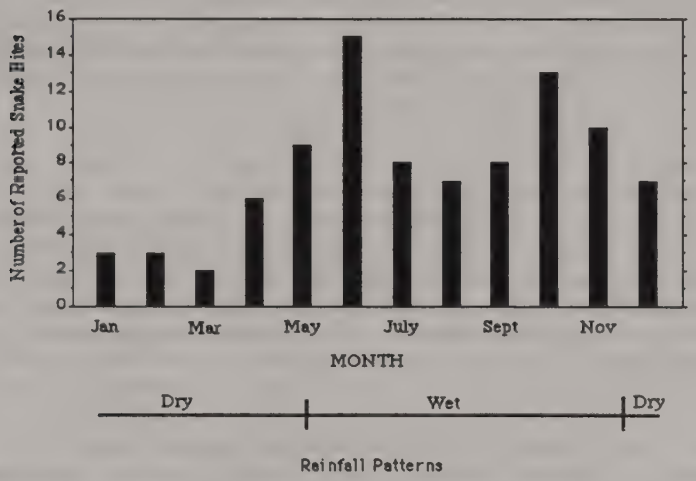

Figure 21. Composite records of *B. irregularis* bites from September 1986 through August 1990. Seasonal component with respect to rainfall patterns is presented in the lower portion of figure. N = 91.

Fritts, et al. (1990) noted a tendency for snakes to attack sleeping children. This trend was not fully explored in that paper because complete data were lacking in many bite incidents. Activity at the time of the bite was known for 36 of the 39 bite victims (September 1989 through August 1990). Of those 36, 30 were sleeping (Fig. 22). Of those 30, 22 were less than six years of age. The age range for all sleeping victims was two weeks to 63 years. Of the 30 bite victims that were sleeping, 18 were bitten on the fingers or hands. Other locations of bites on sleeping victims included arms, legs, necks, backs, and faces. Multiple bites were also recorded for six patients, all less than two years of age. There was no sexual bias in bite victims. Of the 22 bites involving children less than six years old, 10 involved females and 12 involved males.

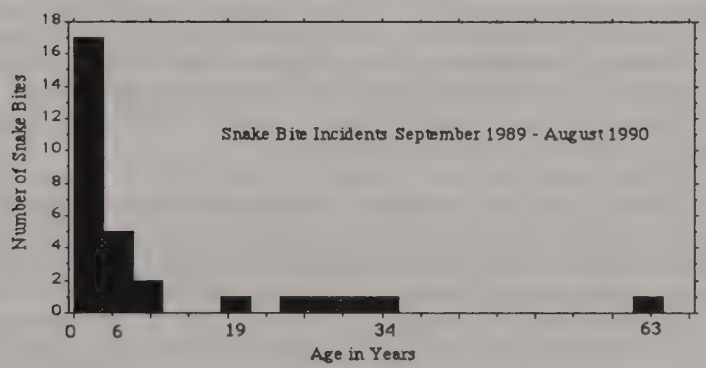

Figure 22. Age distribution of B. irregularis victims bitten while sleeping. N = 30.

Discussion

Minton and Minton (1980) found that the banded krait (*Bungarus* sp.) was characterized as biting sleeping humans but were unable to discern the causative effect. It is documented that *B. irregularis* will routinely attack, kill, and attempt to consume prey that are too large to consume (Fritts, 1988; Fritts, et al. 1990). The pattern of tooth punctures on certain bite victims (particularly on fingers and hands) suggests that snakes were attempting to ingest them. Cues, whether chemical (Chiszar, et al. 1988) or visual (Chiszar, et al. 1990), for attacks remain unknown.

Prey Dynamics

Studies of the lizard prey base of *B. irregularis* continue. At a study site in southern Guam, 176 geckos of three species (*Gehyra mutilata, Lepidodactylus lugubris* (two clones), and *Hemidactylus frenatus*) have been individually marked and followed during the year. While the data are still being tabulated and analyzed, information on movements, growth, and reproductive cyclinghas been obtained. Studies on other species of lizards (*Carlia fusca, Anolis carolinensis*, and *Varanus indicus*) continue on other areas of the island.

The lizard fauna of Cocos (Dano) Island (the last snake-free enclave on Guam), because of the high species diversity, is, arguably, the most unique in the Mariana Archipelago . Species that formerly occurred on Guam proper (*Emoia cyanura, E. slevini, E. atrocostata, Cryptoblepharus poecilopleurus, Gehyra oceanica, and Perochirus ateles*) persist, for the most part, in relatively healthy numbers. Biological profiles continue on all these species.

DISCUSSION

Brown Tree Snakes are exhibiting areal differences in terms of sex ratios and SVL. This may be reflective of the cyclic populations expansions and contractions. In concert with the above, differences in fat content may reflect the general condition of a local population with respect to exploitable resident prey base. Reproductive parameters have changed in the past six years with the trend being increased size at initial ovulation and less follicles ovulated per given SVL. These are all indicative of deteriorating conditions on Guam with populations feeling the effects of a highly altered prey base (= absence of a ubiquitous endotherm prey base). Hypothesized prey shifting from ectotherms to endotherms can now generally occur in urban situations only. Thus, normally distributed populations should become increasingly urban-associated. If these normally distributed snake populations are becoming associated with urban situations, then the likelihood of a serious bite and the incidences of bites might be increasing. Larger snakes may be able to persist in an urban situation because of the presence of adequate endotherm prey. Larger *B. irregularis* may be more dangerous than smaller snakes, as the venom may become increasingly more neurotoxic with size (T. Fritts, pers. comm.).

A strong argument can be made against the introduction of any new vertebrate species to Guam. Seemingly innocuous introductions of certain lizards have proven disastrous as *C. fusca, A. carolinensis*, and *H. frenatus* have overwhelmingly contributed to the success of *B. irregularis* on Guam after the depletion of the native prey base. It is likely that had these three species not been established here, *B. irregularis* would not be as abundant as it currently is.

RECOMMENDATIONS

1. Continue site specific *Boiga* investigations.

2. Continue life history studies of *Boiga*'s most ubiquitous prey base (lizards).

3. Continue age and growth validation and verification studies.

4. Continue monitoring human health risks as related to *B. irregularis*.

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Report prepared by: Michael McCoid

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-5
STUDY NO.: 7
JOB NO.: 3

JOB TITLE: Development and Testing of Control Methods for the Brown Tree Snake

PERIOD COVERED: October 1, 1989 to September 30, 1990

SUMMARY

Laboratory experiments of climbing abilities of the Brown Tree Snake (*Boiga irregularis*) indicated that different climbing behaviors were used on different climbing surfaces. Climbing behaviors that were observed included "Loop Worm," and "L-Ascent" or "Follow-the-Leader." Regardless of size or sex of snakes, a specific type of climbing behavior was used for each test pole. Laboratory tests of an electrical barrier (6V and 12V DC) proved 100% effective in preventing snakes from climbing test poles.

BACKGROUND

Roadside counts by the Guam Division of Aquatic and Wildlife Resources have well documented the decline of the native forest birds of Guam (DAWR, 1974-1988). Studies by Conry (1988) and Savidge (1986, 1987) have indicated that predation by Brown Tree Snake as the main cause of this decline.

Since these studies, attempts to develop adequate and effective means of protecting active nests of the Mariana Crow, *Corvus kubaryii*, have been made. Clearing of vegetation in direct contact with the nest tree, snake trapping, use of galvanized sheet metal girdles, and use of Tangle-Foot have all been used. The use of sheet metal girdles and Tangle-Foot have resulted in the mortality of trees and were discontinued. Clearing of vegetation and snake trapping has met with some success. Possibly, a combination of several methods may prove to be the most effective means of controlling snakes and other possible predators.

OBJECTIVES

To develop methods in controlling snake predation on active nests of native birds.

PROCEDURES

1. Laboratory tests of the climbing ability on different surfaces were conducted.

2. Laboratory tests of alternative and effective means of controlling snakes were conducted.

RESULTS

FY90 saw the initiation of research into the control of Brown Tree Snake predation on nesting birds. Construction of a nine-room outdoor testing facility was completed in the

first quarter, as well as collaborating with other scientists on test design and method. It was determined that control testing would take place first and that field implementation of effective barriers would follow at a later date.

Control testing commenced in December using three different test poles. Test poles used were of three different species and circumferences. Poles used and average circumference (C) of each were: tangan-tangan, *Leucaena leucocephala*, C=20.7mm, *Pandanus* spp. C=41.9mm and coconut, *Cocos nucifera*, C=71.5mm. Only newly captured or donated snakes were used. Once a snake was used for a night of testing it was destroyed and made available to the staff herpetologist for further research. Data collected on each snake was; Snout-to-Vent Length (SVL), Total Length (TL), sex, and date and location of capture. Control testing was completed on one test pole before proceeding to the next. Sequence of test pole used was tangen-tangen, pandanus and coconut. Data collected were type and duration of climb. At least thirty trials were recorded for each test pole.

Testing of tangan-tangan utilized 15 snakes (8m, 7f) ranging from 624-1114mm (SVL). Thirty-one climbs were recorded but only two were timed and they averaged 3 minutes and 07 seconds. The type of climbing mode utilized may be described as coiling or constricting. Here, snakes extended the anterior portion of their body up the pole and then wrapped, constricted and fixed it around the pole. The posterior portion was then pulled up and wrapped, constricted and fixed around the pole just beneath the anterior portion. This "Loop Worm" type sequence was repeated until the snake reached the top of the pole.

Testing of pandanus utilized 9 snakes (6m, 3f) ranging from 624-1268mm (SVL). Thirty climbs were recorded and 24 of these were timed. Average climb time was 1 minute and 42 seconds and the type of climbing mode utilized was best described as an "L" ascent. Snakes extended the anterior portion of their bodies up the pole, making distinct 90° turns and holding the body in this position. The locations of the 90° turns made by the snake were where it was able to secure itself on and against the test pole while proceeding upwards. The anterior portion was then held fixed while the posterior was pulled up along the same route as the anterior. Roughly the anterior and posterior portions of the snakes were on opposite sides of the pole. This "follow-the-leader" sequence was observed all the way up the pole.

Testing of coconut utilized 10 snakes (5m, 5f) ranging from 631-1891mm (SVL). Thirty climbs were recorded and 24 of these were timed. Average climb time was 1:00 min. The type of climbing mode was best described as a combination of concertina and rectilinear. This type of climbing technique is described in the literature for other snakes but not for the brown tree snake (Gans, 1974).

Regardless of size or sex of snakes, a specific type of climbing behavior was utilized for each test pole. Also, no discernable difference could be noted in climb times between large and small snakes on a given test pole. Testing showed that the larger the diameter of a test pole, the quicker the climb.

The testing of various types of barriers was initiated shortly after the control testing was completed. Several barrier designs were tested with only one showing 100% effectiveness on snakes as well as monitor lizards and rodents. This is an electrical barrier. Control testing was accomplished using an electrical fence energizer operated by household current (120 volts). Various energized and grounded wire configurations were tested to determine the most effective pattern for optimum control. Additionally, various voltages were tested to determine an effective range. Both rodents and snakes were effectively repelled by voltages in the 2500-3000v range. However, the shock to a monitor lizard caused it to climb more quickly up the test pole. A reinforced shelf, perpendicular to the test pole, was

attached just above the energized/grounded wire configuration. Then, when the lizard was propelled up the tree it was stopped at the shelf and it circled the pole rapidly, all the while being shocked. Lizards either retreated down the pole or jumped to the ground. Additionally, systems that recorded a voltage over 5000v were more effective on monitor lizards. Using these systems, a lizard would rarely continue its climb after receiving its first shock. Later, a 6v gel battery, solar powered system as well as a 12v lead acid battery system were purchased. Both of these systems were tested in the lab, proved effective and are awaiting implementation in the field.

RECOMMENDATIONS

1. Continue laboratory tests of possible means of protecting active native bird nests.

2. Conduct in situ tests of methods which prove effective in laboratory experiments on actual active nest trees.

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Report prepared by: Michael Ritter and Celestino Aguon

LAW ENFORCEMENT

PERIOD COVERED: October 1, 1989 to September 30, 1990

During FY90, a total of 65 persons were arrested and charged for violating Fish, Game, Forestry and Conservation Laws. Of the 65 individuals, three were arrested and charged for unlicensed cutting of trees on public lands. The arrests were made when Conservation Officers (COs) on patrol duty discovered a series of four-wheel drive trails, which were freshly-cut to retrieve live and dead ifil trees. Ifil wood is used to make furniture, plaques, clocks, ashtrays and various decorative pieces. Pictures were taken of the trails and the live plants that were cut. Several heavy-duty chainsaws were confiscated as evidence in this case. A summary of this report has been submitted and charges have been filed with the Attorney General's Prosecutor's Office. At the time of this reporting, the case is still pending.

Of the 62 other arrestees, 24 were arrested and charged with illegal hunting. These arrestees included two minors, a 12-year-old female and a 17-year-old male. Based on the report, the minors were in the company of adult relatives who were caught illegally hunting on U. S. military property. Both minors were taken into custody and dealt with in accordance with juvenile prosecution procedures. They were later released to their legal guardians with letters instructing them and their parents to report to the Youth Division of the Guam Police Department to face formal charges. A report of this incident was also forwarded to the Attorney General's Prosecutor's Office for information and disposition.

At the end of the reporting period, only one case involving illegal hunting had been cleared by the Superior Court of Guam. The three arrestees involved all pleaded guilty and each paid a fine of $350 including court costs. They were each ordered to perform 100 hours of community service under the supervision of the Department of Agriculture (DOA). The Court further ordered that the total fine of $1,050 be deposited in to the Division of Aquatic and Wildlife Resources' (DAWR) Conservation Fund.

The 21 other hunting violators have been officially charged and their respective cases are awaiting prosecution by the Prosecutor's Office.

During this fiscal year, 38 individuals were officially booked and released for illegal fishing.

The first violation, which occurred on October 18, 1989, involved the captain of a Taiwanese fishing vessel, a 212-foot purse seiner. The captain was arrested and charged with possession of an Endangered Species, specifically, three live Hawksbill turtles, which he and his crew members had caught while fishing in the high seas. The illegal catch was discovered while the vessel was undergoing inspection by Customs and Quarantine after it had docked at the Port Authority of Guam to unload its catch. COs were immediately dispatched to investigate.

Upon investigation, the officers arrested the captain of the vessel and charged him with violating the Endangered Species Act of Guam (Section 1235.5, Subsection (a) Import and export of any such species; (d) violate regulations pertaining to conservation; and (e) possess, transport or ship). The captain was also advised that his vessel would be seized because it was used in the transportation of an endangered species.

At the instruction of the DAWR Chief, the ship was declared seized. A report was prepared and forwarded to the Prosecutor's Office charging the captain of criminal act and

intent and recommending that forfeiture proceedings be filed under Section 12322 to allow confiscated evidence to be forfeited to the Government of Guam.

On October 31, 1989, the defendant appeared in Superior Court and entered a plea of nolo contendere to the charge of possession of Endangered Species (three live Hawksbill turtles). He was represented at the hearing by an attorney and accompanied by his interpreter. The Court was advised that a plea agreement had been reached and was presented with the document executed by the defendant, his attorney and the prosecutor.

The Court addressed the defendant and after determining that the plea was knowing and voluntary, the Court accepted the defendant's plea. It further ordered that in lieu of forfeiture of the vessel, as provided for in Section 12325.8 (e) of the Government Code of Guam, the defendant pay the sum of $35,000 to the Conservation Fund under provisions of Section 12325.8 (f) of the same Code. The Court did not order a fine or any period of incarceration.

Thirty three foreign nationals -- 28 from Korea, four from China and one from Micronesia -- were arrested in separate instances this year for taking live coral and harvesting coral without a permit. All pleaded guilty and were fined a total of $7,500, all of which was deposited into the Conservation Fund.

In one of the more notable cases, the Law Enforcement Section seized a 110-foot longliner, the Sharon 31, on which live coral had been found. The ship had docked at the Port Authority of Guam for repairs after spending two days at sea with engine problems.

The seizure and arrests of four crew members were the result of a tip from concerned citizens who observed crew members taking coral in the Luminao Reef area and carrying the pieces onto the vessel. Immediately after the report was received, COs were dispatched to intercept the group. Coral pieces were found on the four individuals and following a search of the ship, more were discovered stashed in various compartment areas.

After nearly two months of negotiations, the vessel's legal representative agreed to a penalty of $20,000 in lieu of forfeiture of the vessel. The money was deposited into the Conservation Fund and the vessel was then released.

A Korean national residing on Guam was also arrested during this reporting period following the discovery of undersized Trochus shells among his commercial catch. The individual had secured a permit from the DOA to harvest Trochus commercially during the established season. An inspection of his catch by DAWR revealed large quantities of undersized shells. The case has been turned over to the Prosecutor's Office and is currently awaiting action.

Earlier this year, a Micronesian female was charged for possession of sea turtle meat, which she had imported from Palau. Approximately twenty pounds of meat was seized after Customs and Quarantine officials intercepted her shipment. The case has been turned over to the Prosecutor's office for disposition.

Forfeiture actions were filed against eight vehicles, which were confiscated as evidence in illegal hunting and unlawful taking of coral cases. One vehicle has been legally forfeited to the DOA for disposition and the others are pending court action. Two of the three vehicles seized for coral violations have been released after their owners filed petitions for mitigation of forfeiture. The government agreed to return a Ford Ranger pickup truck and a Toyota Hilux pickup to their owners in return for fines of $2,000 and $3,500, respectively. The funds were deposited into the Conservation Fund.

Aside from vehicle forfeitures and fines awarded to the DOA, the court in various instances, turned over to DOA weapons and other hunting and fishing paraphernalia which we had confiscated.

While our Section made numerous arrests this past fiscal year, there were other reported incidents, which were investigated by COs but, did not result in any arrests. Such cases included spotlighting, fish poisoning, fish dynamiting and fruit bat and sea turtle poaching. In many cases, the suspects were either no longer at the scene of the crime or were not arrested due to insufficient evidence in which case, warnings were issued. Field investigation reports of such incidents were submitted and filed for future reference.

In June 1990, two of our COs attended the U. S. Fish and Wildlife Overt/Covert Investigation Seminar at the Federal Law Enforcement Training Center in Glynco, Georgia. The training gave us the opportunity to learn more advanced investigative methods and techniques and to share that knowledge with our fellow officers. It is recommended that other conservation officers be given similar training opportunities in the future.

At the end of the reporting period, the Law Enforcement Section received a total of $169,965 from the General Fund for supplies, equipment, a temporary building and the recruitment of three additional officers. Our force of eight officers has decreased following the resignation of one officer due to personal reasons.

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